INVESTIGATION OF THE FAILURE OF STATISTICAL PROCESS CONTROL IN MANUFACTURING INDUSTRIES IN SOUTH AFRICA.

CASE STUDY - Atlantis Diesel Engines

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This thesis has been presented in partial fulfilment of the requirements for the degree of Master of Science in Engineering Management at the University of Cape Town

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DECLARATION

I, the undersigned, thereby declare that the work contained in this thesis is my own original work and has not previously, in its entirety or part, been submitted at any university for a purpose of a degree.

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Rockson Boamah Ansah Date

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TABLE OF CONTENTS

APPENDICES AND EXHIBITIONS

TABLE OF FIGURES

LIST OF TABLES

ABSTRACT

This work strives to give an insight into why Statistical Process Control (SPC), a quality management tool, is not yielding desired results in some manufacturing industries such as Atlantis Diesel Engines in the Western Cape.

Statistical Process Control is an improvement technique that, when properly used, can improve both the quality and the productivity levels which may subsequently improve the competitiveness of a company. SPC achieves this by highlighting when a process is out of control. This happens at the source and a very early stage. The advantage of this is that in the case of manufacturing, rejects are limited and in some cases prevented depending on the relationship between process capability and specifications. The aim of SPC is to reduce variability of characteristics of a product.

Wetherill and Brown (1991) revealed that many organisations regulated the quality of their products with SPC during the Second World War. This gives an idea of how long SPC has been in existence. The widespread use of SPC nearly came to an end in the 1960s. The reason for the abandonment of SPC by leading manufacturing industries in most parts of the world was not clear but the belief was that at that time industries were prospering, with little or no competition. However, in the late 1970s, the Japanese industries took the market by storm by the use of quality management techniques and tools, which were introduced by quality gurus such as Deming, Juran, Crosby and many others. This gave the incentive for organisations that wanted to be world class players in their respective sectors to reconsider exhaustively the use of SPC and its tools.

In South Africa, predominantly in the Western Cape, SPC has been reintroduced in many companies over the past eight years. The introduction of SPC in most of the industries has not been a smooth transition as it was based on the misconception that if enough of the "right" improvement activities were carried out, then actual performance improvement would improve. There have been many factors hindering the successful implementation of SPC in manufacturing industries such as ADE. This research aims to identify these factors.

The research comprises five parts:

- **Overview of SPC** - This part of the thesis focuses on process control, basically statistical process control tools, the type of statistical process control systems available and their advantages and disadvantages, process capability study, and variations and their interpretation.

- **The development of the problem statement** - This part of the thesis firstly, reviews the promises, problems and issues associated with the use of Statistical Process Control. Secondly, the case study (ADE) for the research was analysed in order to identify the problem and subsequently determine the appropriate measures to be taken in order to harness the full potential of Statistical Process Control.

- The development of a comprehensive research/inquiry framework; this inquiry framework is based on the philosophical work of Charles Saunders Peirce and the learning cycles proposed by Deming, Kolb, Handy and many others. Action research was chosen as the research methodology for this work.

- The implementation of the research framework with the objective of understanding an organisation from the systemic point of view. Effective management of an organisation needs an appropriate management intervention based on the systems approach, in this approach the organisation is seen as a bigger system made up of parts that are interdependent and interrelated. The philosophy of inquiry and its relevance to effective management was explored. Conditions for creating a learning organisation based on organisational learning and its competitive advantage were discussed. In creating a learning organisation emphasis is placed on organisational culture and behaviour and how it influences the introduction of programs such as Statistical Process Control. Managing an effective organisation from the cybernetic point of view, using the Viable System

Model (VSM) to diagnose the organisational and managerial issues was also addressed.

- The result, conclusions and recommendation; this part illustrates the reflection on the learning process based on the validity of the inquiry framework in a real world situation.

The causes of failure of SPC at ADE were identified to be the following: poor communication particularly between production and quality departments, lack of commitment on the part of management indicated by lack of policies as well as employee training that would enforce the success of SPC at all levels, and a weak control function which implies a lack of responsibility and accountability from employees for their contributions to the processes.

The following recommendations were made: communication channelling systems should be improved, team work should be encouraged with the aim of improving communication channels between functional departments, further research should be carried out into the feasibility of the proposed model which aims at ensuring the successful implementation of SPC.

CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND TO THE RESEARCH

Organisations world-wide are striving to achieve a high quality in their business processes. The fast changing technology and the dynamic business environment are forcing organisations to search for ways and means to stay competitive. The acceptable levels of quality of products are the basic requirements for manufacturing competitiveness. As a result organisations with foresight for long term planning are embarking on improvement programmes, such as Statistical Process Control (SPC), Quality Function Deployment (QFD), and Business Process Reengineering (BPR) to mention a few.

The above mentioned levels of quality are set by the International Standard Organisation (ISO). Among other things, ISO recommends the implementation of SPC because of its ability to bring a process to a more stable state. Consequently, SPC has become an essential tool in many manufacturing processes. It is for this reason that this research focuses on SPC.

SPC is a technical tool that can be used to control and improve any type of process where statistical data can be collected. It is a simple, powerful, production-and quality-management and marketing tool that increases profit by giving new insights into the production process (Arend Hofmeyr). Statistical Process Control can also be described as an improvement technique that, when properly used, can improve both the quality and the productivity levels which may subsequently improve the competitiveness of a company. SPC achieves this by highlighting when a process is out of control. This happens at the source and a very early stage. The advantage of this is that in the case of manufacturing, rejects are limited and in some cases prevented depending on the relationship between process capability and specifications. The aim of SPC is to reduce variability of characteristics of a product.

The philosophy behind Statistical Process Control can be described as a systems approach to quality management. This philosophy has been articulated by quality gurus such as Dr. W. Shewhart (1986) and Dr. W. E. Deming (1982). It is said to be systemic because it has an input, an output, and operating conditions as illustrated in figure 1-1.

Operating conditions such as materials, methods, equipment, people and environmental factors affect the transformation output. These variables are subject to change as they are affected by random factors that can be an inherent part of the system or can be externally caused.

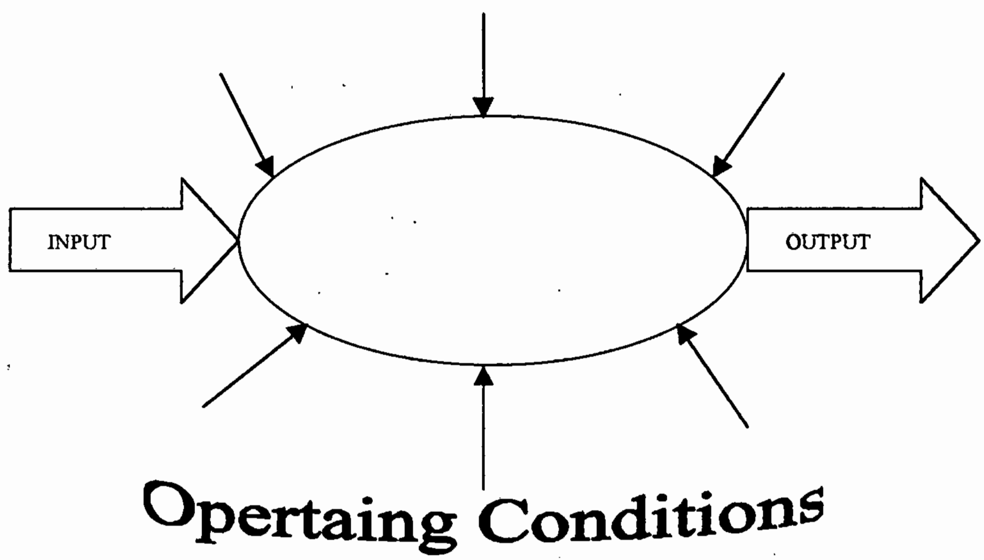


Figure 1-1: SPC AS A TRANSFORMATION PROCESS

Statistical Process Control encompasses the following schools of thought:

- Quality is conformance to specification.
- Products and processes are subject to variation.
- Variation in processes and products can be measured.
- Variation follows identifiable patterns.
- Variation due to assignable causes distorts the bell shape.
- Variation can be detected and controlled through statistical process control.

One of the limitations of SPC is that it can only be used where variations are stable. Hence it can not be used in production scheduling where the cause of variations namely; orders, products and clients is not stable.

SPC may be applied to processes such as: extrusion of plastic sheets and blown films; injection moulding; blow moulding; foam extrusion and forming; thermoforming; paper tube manufacturing; beverage and pharmaceutical fill volume control; and checking incoming raw material consistency, to mention a few.

According to Arend Hofmeyr, a consulting engineer (Qualistat SPC system), SPC has been in use for many years world-wide. In South Africa, particularly the Western Cape, a substantial number of factories have been involved with SPC for the past eight years. These include packaging companies such as Nampak, Kohler and Consol, the bottlers of Coca-Cola and bottle manufacturers in general, and the pharmaceutical manufacturing industries.

1.2 BENEFITS OF THE PROPER USAGE OF SPC

Most repetitive tasks such as those performed in the service and manufacturing industries can be monitored and controlled by SPC. Statistical Process Control improves quality and reduces waste in the manufacturing, assembly, and other processes.

When used properly Statistical Process Control may:

- Limit rejects and in some cases prevent them.
- Provide a better understanding of a process.
- Reduce scrap and optimise performance.
- Generate historical information.

Inspecting every item is costly, and inspecting only one sample at a time can give a misleading result. SPC overcomes this by sampling a small group, comprising five samples, at regular intervals.

Research into the fundamental benefits of SPC indicates that the worst case pay back period is about six months. A streamlined process employing SPC for the first time stands to gain, at a conservative estimate, raw material savings of at least 0.5 to 1%. This approximates to annual savings of up to R200, 000 by companies with an annual raw material bill of R20 million (Hofmyer).

The author proposes Statistical Process Control as a tool that management may use to monitor and improve their production process. The exhaustive and proper usage of SPC tools brings a production process to a more stable state from a chaotic one, by removing all the assignable causes of variation, and by promoting a learning organisation.

SPC is a simple statistical tool that operators, either skilled or unskilled, can be trained to use.

1.3 OBJECTIVES OF THE RESEARCH

The objectives of this research are to:

- Inquire and describe the current situation at ADE and determine the problems encountered in the implementation and utilisation of Statistical Process Control as a quality management tool in manufacturing industries.
- Design a model that can be used for improvement of the current problematic situation.
- Make recommendations based on the designed model.

1.4 RESEARCH HYPOTHESIS

The hypothesis formulated and selected for this purpose was:

"The use of Statistical Process Control as a quality management tool in manufacturing industry may enhance quality and productivity by stabilising manufacturing processes. The full potential of SPC may be harnessed by ownership, accountability, training and commitment at all levels in the organisational hierarchy."

Literature reveals SPC as a quality management tool but practically SPC implementation and utilisation has not been successful in some organisations. The author attributes the non-viability of SPC in most manufacturing industries to the misconception by management that if an organisation embarks on improvement programmes, conditions will improve drastically. This often results in management choosing improvement programmes without considering the consequences associated with their implementation. It is on this grounds that the hypothesis of this work is based. It is a known fact that that SPC has been and it is still successful in some manufacturing organisations in South Africa and world-wide.

The hypothesis selected must satisfy the criteria set by Peirce (Reilly, 1970, p 38) as elaborated in chapter six. The conditions require the hypothesis to be:

- Verifiable experimentally. The verification is based on the fact that SPC has been and is still being used successfully by some world class manufacturing industries in stabilising their manufacturing processes and products quality.
- Economical, with resources controlled in terms of time, money, and energy. The use of SPC is economical in that once it is well utilised, organisations can save up to 2% on their annual raw material bill. Although training requires time and energy, the use of SPC may show a significant improvement in production processes and products quality, which in effect saves organisations money on labour time and resources.
- Easily proved for truth or refuted for its falsity. This can be achieved using the scientific method of reasoning proposed by Peirce (Reilly, 1970) and Minto (1982).

1.5 THE CASE STUDY FOR THE RESEARCH

Atlantis Diesel Engines (ADE) was chosen as a case study for this research because of its historical background. ADE is an automobile industry, it is a manufacturer and distributor of diesel engines and spare parts of diesel engines. It is as one of the oldest and biggest manufacturing industries in the Western Cape which implemented Statistical Process Control as a quality control tool. SPC was first implemented at ADE in 1982. Its failure in yielding the desired results has been a concern of management, which prompted this investigation.

1.6 RESEARCH METHOD

There are dozens of research methods and approaches available for managerial inquiry and investigations, as stated by Gill and Johnson.(1991) These include:

- Experimental research
- True experiment
- Quasi-experiment
- Action research
- Survey research
- Ethnography.

The action research approach was considered appropriate for this research work. The reason being in action research approach, the research is carried out in a given problem area with the intervention of a researcher who may be an employee or an external consultant.

In the action research process the first stage involves the establishment of a problematic situation and problem definition. The second stage in the action research framework is the formulation of *goals* and *assumptions*. The third stage is concerned with the collection and analysis of the relevant *data*. These pertaining data should reflect the understanding of the situation based on the goals and assumptions formulated in the second stage. If the data do not reflect the understanding of the situation, the researcher would then have to revisit the previous steps and adjust the goals. The fourth stage is the choosing of the right option. This is based on the data and the theoretical context, which forms part of the pool of knowledge. These options are formulated and one undergoes a comparative phase which is essential to double loop learning (see section 6.5.1). The most effective option is then chosen and leads to the final step of *action* where the option chosen is implemented.

There is a continuous feedback loop to ensure that rigour and relevance is maintained throughout the cyclic process. Feedback is also essential for an effective learning process as well as a control mechanism to ensure shared vision among the people involved in the process. Since the process is cyclic it should be revisited to review continuously the decisions emanating from it.

The action research process is shown schematically in figure 1-2.

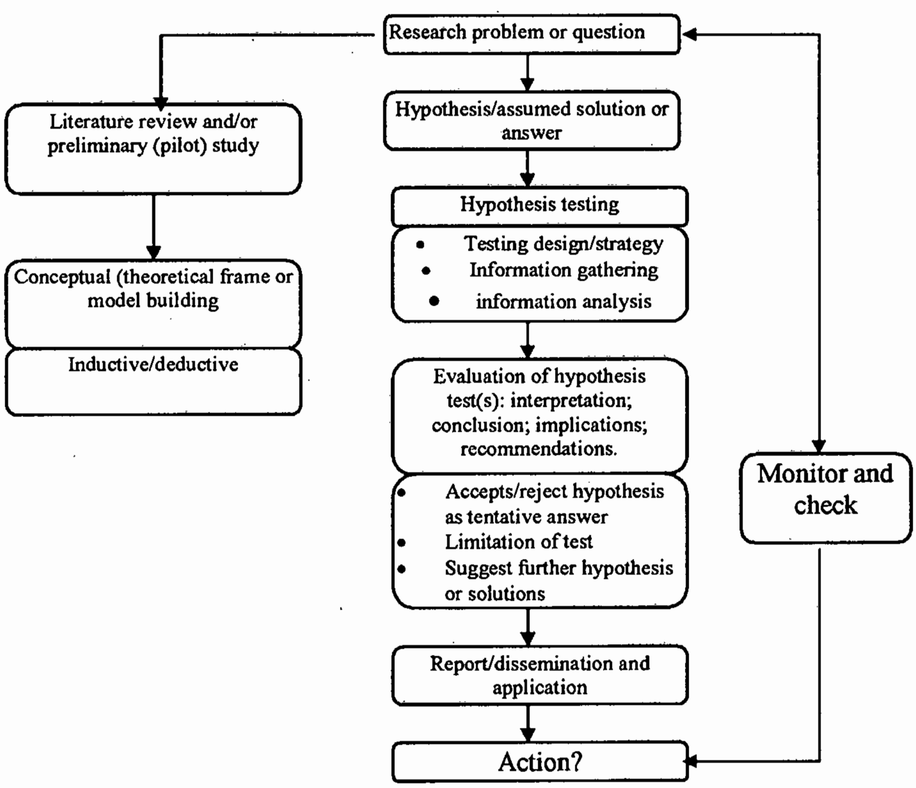


Figure 1-2: ACTION RESEARCH PROCESS (Bennett R and Oliver J, 1988)

Action research focuses on problems and the fact that the action and the effects of the action can lead to understanding of the dynamics of the situation under controlled condition. Although action research method was the method chosen at the beginning of the research not all the processes in the action research process were performed as stated by Bennett and Oliver (1988) in figure 1-2.

1.7 SCOPE AND LIMITATION OF THE RESEARCH

The research focuses on Statistical Process Control in the manufacturing business unit, specifically the crank cell at Atlantis Diesel Engine (ADE). The methodologies used in gathering information and data were geared towards obtaining information relevant to SPC in the crank cell. Due to time constraints, the model designed by the author could not be tested under real life conditions. However, the implementation phase was outlined.

PART ONE

OVERVIEW OF STATISTICAL PROCESS CONTROL

This part of the thesis focuses on the overview of statistical process control, basically statistical process control tools, the type of statistical process control systems available and their advantages and disadvantages, process capability study, and variations and their interpretation.

CHAPTER TWO
SPC TOOLS AND INTERPRETATION OF VARIATION

This chapter discusses the Statistical Process Control tools often used in the interpretation of data collected or generated by the use of SPC system. It also elaborates on variation and its interpretation. Statistical Process Control as discussed in chapter one is a process monitoring technique where data is collected after measurements are taken. The data is analysed using SPC tools to determine the various sources of variation. These tools are used in the analyses for assignable and chance causes of variations hence the need to explore them thoroughly. In all processes variation is evident. This consequently calls for managerial knowledge for its interpretation.

2.1 MEASURING PROCESS

Generally Statistical Process Control is not very expensive. The cost largely depends upon the method used in collecting and processing data. Measuring instruments, even when correctly used may not give a true reading of a characteristic. The difference between the true value and the measured value can be due to problems resulting from inaccuracy and lack of precision.

- **ACCURACY**

The accuracy of an instrument is the extent to which the average of a long series of repeated measurements made with the instrument on a single unit of product differs from the true value. The difference is usually due to an assignable reason or error in the measuring.

- **PRECISION**

The precision of an instrument is the ability of an instrument to repeat its results when making repeated measurements on the same unit of product.

2.1.1 TYPES OF DATA

Making use of SPC needs data, and the accuracy of the data taken is important since the control chart generated is a function of the data collected. Basically, there are two types of data- attribute and variable data.

- **VARIABLE DATA**

Data derived from incremental measurements are called variable data. Variable data reveal the extent to which a measured variable conforms to specification.

- **ATTRIBUTE DATA**

These are data obtained from measuring instruments that either accept or reject a manufactured part. These data are classified in terms of:

- good/bad
- acceptable/unacceptable
- conforming/defective, or
- go/no-go

2.1.2 TYPES OF SPC

Statistical Process Control falls under three main categories depending on how data is collected and processed.

- ***MANUAL***

The traditional method using a standard SPC form. Readings are recorded on a sheet, along with the time and the name of the operator. A quick look at the chart for any trends is usually enough to check for any potential problems.

Advantages - flexible and requires no special equipment.

Disadvantages - operator training, less reliable, time consuming.

- ***SEMI-AUTOMATED***

Information is entered directly into a computer, either by typing or by a gauge linked to the computer. This permits automatic alerting on potential problems, improved reliability, and easy access to the information by other people (Quality Control, Supervisors, etc.) and other packages. This is ideal for manual operations or post-process inspections.

Advantages - better analysis, reduced training, easy access.

Disadvantages - operator interaction and the necessity for a nearby computer.

- *FULLY-AUTOMATED*

A computerised monitoring equipment is directly connected to the machine which records both process parameters and machine status This can be done by connecting to a machine controller or directly to special sensors.

Advantages - minimal operator intervention.

Disadvantages - expensive and difficult to implement.

Interfacing to machine controllers is less expensive and allows easier selection of parameters, but past experience has shown that the accuracy and resolution may be unsuitable for process monitoring. Interfacing to special sensors gives more accurate results, but can be very expensive and inflexible should it be necessary to monitor a selection of parameters over a number of machines.

The manual system is being employed by Atlantis Diesel Engines.

2.2 STATISTICAL PROCESS CONTROL TOOLS

SPC tools are ways of organising and analysing numerical data for problem solving. They are simple statistical tools, that operators can be trained to make decisions affecting the quality of their daily operations.

Statistical Process Control tools illustrated in Exhibit 1 in the appendix, are used to enhance problem solving. The commonly used tools are the Pareto analysis, Check sheet, Histogram, Scatter diagram, Control chart, and Run chart. There are other tools such as Cause-and-effect diagram and Process flow chart that can be used in conjunction with SPC tools in problem solving.

One main challenge facing management in manufacturing industries is the proper utilisation of statistical tools in problem solving and analysis. At ADE the level of education at the shopfloor is relatively low with respect to the technology employed in the manufacturing process. Management's responsibility is to provide conditions such that employees can appreciate the use of statistical tools in problem solving and analysis.

▫ BRAINSTORMING - A DOWNPOUR OF IDEAS

In the problem solving process, the problem needs to be identified and its causes determined. Brainstorming is a group problem solving method where problems are identified and suggestions for the causes are gathered, by a group of people pouring out ideas and sorting them into required categories.

▫ CAUSE AND EFFECT DIAGRAM - ORGANISING THE BRAIN STORM

The cause and effect diagram, also called the fishbone or Ishikawa diagram, can be used as the second stage of the problem-solving method. It organises the brainstorm of ideas by group members into categories, mainly machine, method, material, environment, and operator. Major factors appear diagrammatically as lines (or big bones) emanating from a major straight line (spine) that represents the problem at hand.

Reasons for using cause and effect diagrams

- It organises and sorts out ideas from brainstorm session into basic categories.
- It shows relationships between ideas.
- It is used to understand situations better.
- It can be used together with the control charts as a problem-solving tool.
- It helps teams or groups involved in problem solving process to keep track of their performance.

Types of Cause and Effect Diagrams

There are two types of cause and effect diagrams, the commonly used fishbone diagram and the process C and E diagram. The former follows the process through each step of the manufacturing or assembly process. It is recommended for a manufacturing process where there are numerous series of operations.

Brainstorming and cause and effect diagrams are two methods that can be employed to find the causes for production problems.

Figure 2-1 shows an example of Cause and Effect diagram for quality improvement programme.

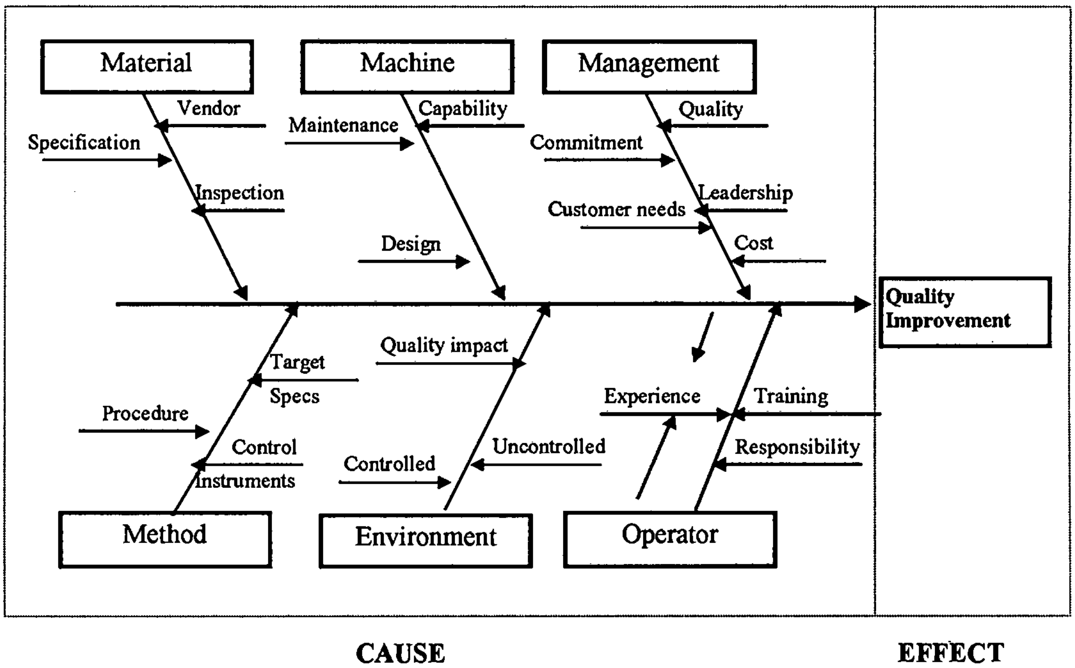


Figure 2-1: CAUSE-AND-EFFECT DIAGRAM

Although cause and effect diagrams are not statistical in nature, they are considered as tools because of the assistance and insight they provide in helping to solve problems.

▫ PARETO ANALYSIS

Pareto analysis is particularly useful in dealing with chronic problems since it gives an indication of which problem to attack. It highlights severe problem areas and recognises that a small number of causes of problems (20%) may result in a large part of the total effect (80%). Pareto analysis applies the 80/20 to identify a few significant causes that account for most of the problems. It separates the '*vital few*' from the '*trivial many*'.

In organisations, problems that might seem threatening receive more attention than less threatening ones. Effective managers and problem solvers need to sort out the few really important problems from the more numerous but less important problems. Pareto analysis sets priorities on problems that need to be solved and the preferred order of solution. The Pareto analysis is a statistical process control tool that can be used for this purpose.

Steps In Construction of A Pareto Diagram

i. Specify your goals
ii. Collect data
iii. Tally data
iv. Rank the categories by frequency
v. Prepare the control charts.
vi. Make calculations based on tallies
vii. Complete/draw the Pareto diagram

▫ RUN CHART

It is a charting of sample results, normally a sample reading at a time in a chronological sequence. Run charts depict a long-term trend of a process based on the sample taking, and at times reveal some unexpected process behaviour characteristics. The run chart can be used basically as the first step in the statistical analysis of a process.

▫ CHECKSHEET

A Check Sheet is a widely used method for collecting data by defining categories and making a mark for each event in each category. There are three types of Check Sheets: attribute; variable and location check Sheets. Check Sheets serves varieties of purposes including:

- Provision of a systemic means of collecting and analysing data.
- Generation of categories of defects and number of occurrence per category.
- Data collected over a number of parts may direct attention towards a systemic cause of defects in a particular location.

▫ SCATTER DIAGRAM.

The Scatter diagram is a statistical tool that graphically illustrates the relationship between two quantitative variables. Plotting points of the two variables of interest on sheet reveals a relationship that can be determined by calculation or drawing a line of *'best fit'*. The existence of any causal relationship between the variables can not be firmly established by only the scatter diagram but through further investigative works such as testing and experimentation.

❑ FLOW CHART

A flow chart is a diagram that shows the progress of work or the flow of materials or information through a sequence of operations. The flow chart is an excellent way in studying a process for the purpose of finding means of further improvement. Although a flow chart is not a statistical tool, if well drawn it can show the relationship between control charts and process capabilities as shown in Figure 2-2 (Flow chart of strategy for process improvement).

The strategy depicted by a flow chart such as the one shown depends on the understanding of the relationship between control charts and process capability studies.

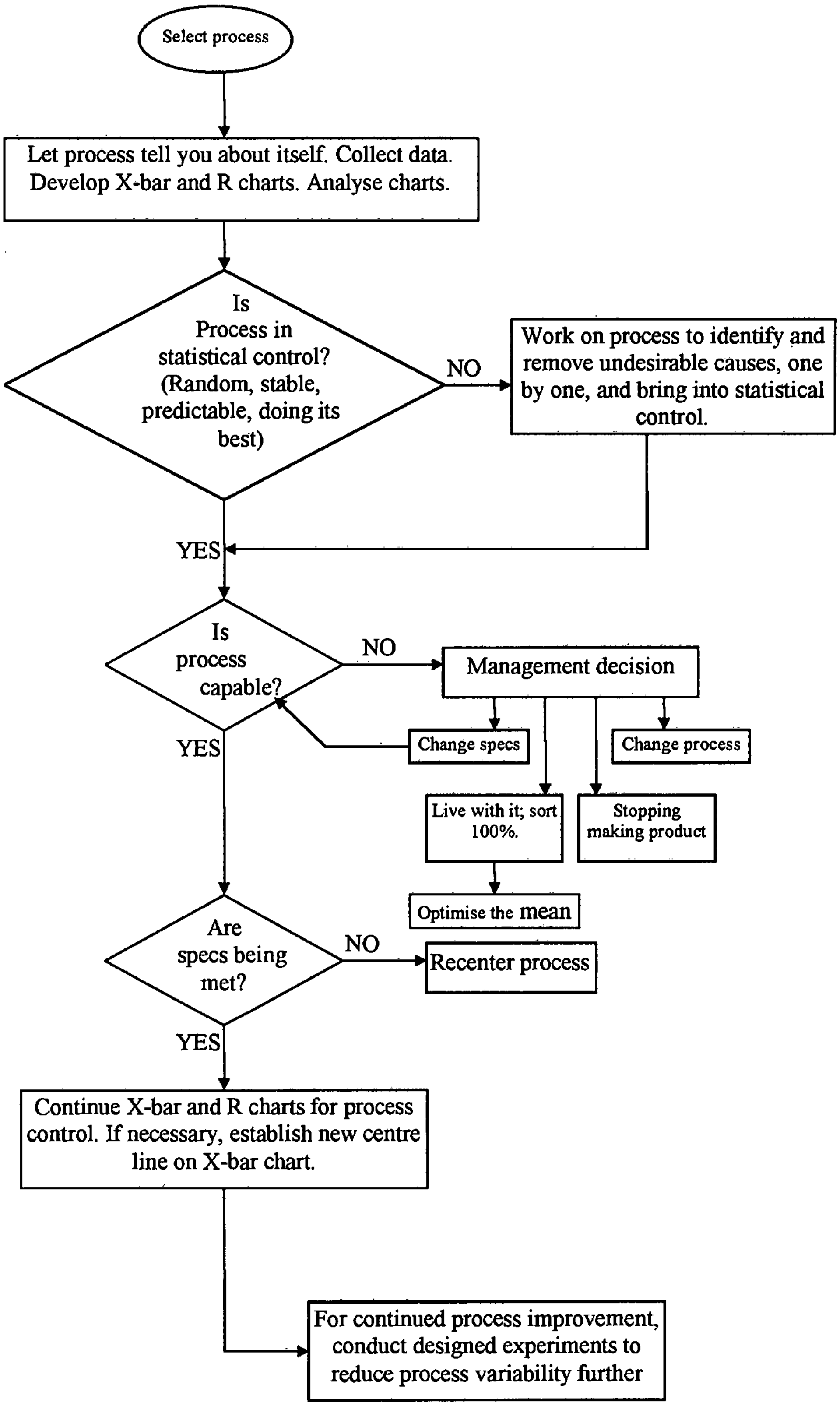


Figure 2-2: FLOW CHART OF STRATEGY FOR PROCESS IMPROVEMENT

❑ FREQUENCY HISTOGRAM

This is the fundamental tool of Statistical Process Control that graphically displays data gathered during the process to show the extent and type of variance within the system. The histogram illustrates three basic characteristics of data:

i. A sense of magnitude of the mean
ii. A sense of variability in the data
iii. Some ideas of the possible pattern of variation, useful in making predictions about the process that generated these data.

❑ CONTROL CHARTS

The Control Charts and rules for their interpretation provide managers with a means to make a clear and repeatable judgement of the state of variation of a process of interest. Before any interpretation can be done based on a Control Chart there needs to be a clear distinction between special causes and common causes of variation. There are different types of control charts, the type used in a particular situation depending on the type of data available and the information required, as illustrated in Exhibit (2) in the appendix.

The control Chart provides a means:

- To study and assess variation and to judge whether it is stable.
- To maintain a continuous record of results so that the effects of changes to the system can be seen.
- To receive a signal of changes whiles the process is in progress.
- To reveal through the pattern of variation information about causes of that variation.

For a chart to be meaningful it must be '*in control*', which basically means that it is behaving in a manner which would be expected. Under normal conditions a process parameter would vary in a random manner around an expected value. Should this variation cease to be random and suddenly become more predictable, such as a regular rising or falling, then it is possible that something has changed which, if left unchecked, may cause the process to start producing items of an unacceptable quality, also known as scrap.

Process Control versus Process Capability

Control Charts indicate whether or not statistical control is being maintained and provide us with other signals from the data. After a process has been brought into a state of statistical control, a process capability study can be initiated to determine the capability of the process in regard to meeting the specifications. It would be illogical to undertake such a study if the process is not in control, since the objectives should be to study the capability of the process after all problematic causes have been eliminated, if possible.

When to Use, Where to Use, How to Use Control Charts

- It is impractical to think of using Control Charts at every station in the process.
- The nature of the products will often preclude the measurement being made at the various stages of production. Control charts are recommended at points/ stages where trouble is likely to occur (critical processes).
- When control charts are first implemented, they should be used in stages where the potential for cost reduction is substantial. This attracts management attention and support for its continual usage.

Benefits Of the Use of Control Charts

- Whether Control Charts are being used for administrative application or for process control (or both) good records are essential if company-wide quality control is to become a reality.
- The more Control Charts are maintained the lesser the variability, simply because the operators realise that management is placing a considerable emphasis on product quality, and this causes them to exercise care.

2.2.1 SUMMARY OF SPC TOOLS

When a process is first monitored there is, initially, insufficient data to derive the control limits or to analyse for trends. To overcome this a Preliminary Process Study can be performed to generate sufficient data as quickly as possible. Since most SPC charts consist of 25 groups of data, and the smallest group size is 2, then 50 readings are required as a minimum. To cater for the short-term nature of these charts permitted limits are adjusted accordingly.

As the charts are being generated there may be trends seen which might indicate that the process is drifting out of control. These should be highlighted as SPC violations and the cause checked to see if it might compromise the process being monitored. They are not error conditions. If left unchecked then the process may have changed, and will continue to change, until poor product is produced. This provides the real-time prediction of possible problems, and should not be ignored. Of course certain process parameters may naturally generate these trends during normal operation and the ability to disable detection of some trends is normally allowed.

Control Charts give an indication of whether or not a process is in statistical control, but not how to improve the process. Brainstorming, cause and effect analysis, and Pareto analysis are very powerful tools for process improvement. Pareto analysis and flow charts when properly utilised increase awareness with regard to severe problem areas. Cause and effect diagram together with control charts may improve the problem solving skills of the individuals and in effect promote organisational learning that is belief to be a source of competitive advantage.

The areas of appreciation of the different SPC tools are shown in the in Table 2-1 below.

ACTIVITY	TYPICAL PROCESS TOOLS USED
I) Gain Process Control by:	
• Eliminate Special Causes	C-E diagram; C_P /C_P; ;Check Sheet
• Observe Causes of inherent Variation	Histogram
II) Determine Process Capacity	C_P /C_P; ;Check Sheet; Histogram
III) Maintain Process Control	Control Chart Scatterplots Histogram
IV) Improve Process Capabilities	C-E diagram; Histogram; Process Flow Analysis; P-D-C-A; C_P/C_P; Check Sheet Brainstorming

Table 2-1: ACTIVITY AND SPC TOOLS SUITABLE FOR THAT ACTIVITY

2.3 PROCESS CAPABILITIES

When variation in a system is only due to random causes, the process is said to be in control. The range over which this variability occurs is often referred to as the process capability. A measure of this variability which is usually in terms of the process standard deviation, is one of the parameters of the process.

Capability studies are conducted in order to estimate the process parameters which can then be used to determine the ability of the process in question to meet the required standards and specifications. This information may also be used to either establish new standards for the process or modify the existing standards. In a process capability study the variability in important product characteristics is examined and the extent to which the process is capable of producing a product that conforms to specifications is determined. The objective of process capability is to take measurements that help to highlight the causes of process variation.

This study addresses the following questions:

i. What are the contributions to the variability of the product?
ii. Where and why does defective quality arise in the process?
iii. Where and how can this be detected?
iv. What is the product capability index?
v. Which control actions can be taken on a process?
vi. What is the effect of these actions?
vii. What type of control is appropriate and where?

An initial process study comprises three stages:

i. A study of the whole process as a system and a listing of its variables.
ii. Data collection at specific points in the process.
iii. Analysis of the data.

The first stage yields an outline flow chart of the system in which the variables or parameters of the system are classified as follows:

- Input variables: These relate to the amount, the quality and properties of the input material.

- Process variables: These are the pressures, cycle times, temperatures etc of the process.
- Product variables: These are purity, strength, and dimensional or other measurements on the product.

At this stage the amount of control possible on these variables can be established.

The second stage i.e. the data collection phase requires special attention. Several variables may need to be monitored, possibly at various points in the process. When the sampling is done in-groups then at least five readings at a time are required. The frequency of the observation should be sufficient to determine the rate and the manner in which the process variation occurs. In the third stage the data is analysed using methods such as:

- The use of moving –average: this is a method of smoothing data plots in order for cycles, trends etc. to be seen clearly.
- CuSum plotting: Cumulative Sum plotting is a very useful technique, which highlights changes in process average level. The objective is to enable one to subtract the overall mean from the data and cumulate the difference.

After the initial process capability study a Shewhart or CuSum chart is set up. When these charts are used, special causes of variations called assignable causes can be identified. These could either be eliminated or controlled. The very operation of the charts often changes the properties of the process. This may in turn necessitate a new study to be carried out and subsequently a new set up for the charts.

Any process that has a measurable output and operates under stable conditions, will generate an output that varies about a central value in a predictable manner (that can be predicted or a predictable central value). When estimating process capability, the minimum range of the process variable has to be determined. The latter comprises at least 99% of the value of the output generated by the process and is determined by the standard or mean value and the standard deviation of the process variable. After the mean value and the standard deviation are obtained, the range within which variability is considered to be acceptable for the process under investigation is then established.

At this stage an appropriate probability model that simulates the behaviour of the process variable is selected. The normal distribution is commonly used to model industrial processes. For processes that can be modeled by normal distribution the acceptable variability is assumed to encompass six standard deviations.

In data from complex processes; cycles, trends and auto correlation are frequently present. In addition, sudden changes of levels are found. These changes can be traced to new batches of raw material, changes in operating conditions or other special or assignable causes. The first step in implementing SPC would be to detect these types of variations and eliminate them if possible.

The amount of work involved in data collection and presentation is enormous and hence requires the use of an appropriate statistical or SPC computer package.

2.4 VARIATION AND ITS INTERPRETATION

"Variation is the product of any system;... management is to study variation, with the proper theory to unravel the message that the variation is trying to tell us about how to improve the process". - W. Edward Deming.**(Carlson et al, 1989)**

Management must be aware that systems produce variations and these variations are in turn affected by variation in their inputs and in the external environment. Variation in results carries messages concerning the process or systems that generate them. Managers who have knowledge of the variation in the processes they manage have competitive advantages over those who do not, besides this there are other more management techniques that are important for the survival of organisations.

To manage variation managers need to recognise variation, interpret the message it contains about the system and then act accordingly using the appropriate tool at the right time to bring the process into a statistically controlled state. Knowledge of variation helps to keep managerial effort focused on the system under consideration.

The use of information on variation may serve as the basis of two kinds of activities:

i. Monitoring process results and taking action to intervene in the process upon statistical signal of change so that the process is brought back to its formal state.
ii. Application of the information contained in the observed variation to develop an increasing understanding of its cause and effects relationships can be used to change the process and improve future results.

❑ TYPES OF VARIATION

There are two types of causes of variation:

i. Chance (random) causes are a natural part of the system. All manufacturing as well as service processes have natural variations.
ii. Assignable (special) causes are present when a pattern of behaviour of production is established and all of a sudden a deviation from the pattern is observed.

- **KEY IDEAS OF VARIATION**

- One of the aims of process improvement is to reduce the amount of undesirable variation present in the system, its input, and its output.
- Schwarts (1986) made a distinction between stable (statistically controlled) variation and unstable variation and devised the statistical control chart that can be used to study variation and link it to its causes.
- Variation is directly manifested in products or services, and it also makes its way into the final outcome through cost, timeliness, or availability,

2.4.1 THEORIES FOR INTERPRETING VARIATION

Managers use different theories to interpret the meaning of variation produced by organisations and its subsystems. According to Argyris, human beings have sets of programs embedded in their minds, which determine how they control things (Argyris 1990). The first is the set of beliefs and values people hold about how to manage their lives (espoused theories of action). The second is the actual rules they use to manage their beliefs (theories-in-use).

Observing and analysing the way and manner managers contend with difficulties and react to variation may identify three theories employed by managers.

1. Variation should not exist. Standards and practices should produce uniform results when rigidly followed. People are always to blame for failure to adhere to set standards. This is a demotivation factor and contradicts the successful Japanese management system.
2. All variation is the result of something exceptional to be minutely analysed and acted on. Managers overreact by making changes in the system that results in a worse case than before. This normally happens because the situation is not well understood from a systemic point of view.
3. Variation in any kind of results exists because of actions and interactions of the causes that produce the results. Variation of this kind results from two kinds of causes:
    i. Causes that act on every result and are part of the design of the system and the everyday practices and policies that are used to manage it.
    ii. Causes that are special in that they act only at certain times or location.

The third theory is consistent with the modern concepts and practices of system management and improvement so that it is useful to interpret the meaning of variation. Variation in this context is treated as a source of knowledge about how the system operates.

Shewart's (1986) theory of variation provides a useful method to interpret the performance of a process or system, to relate observed variation to its causes, and to determine a cause of action to bring about improvement. According to this theory variation may be stable or unstable.

Stable variation is variation of consistent magnitude, with the results fluctuating around a steady average value.

Unstable variation can be seen in a series that has an inconsistent magnitude of variation, changing over time, or showing some kind of systematic pattern.

Procedures used to produce products and process designs and the practices employed to put variation variables (materials, equipment, methods, people and supervision) in place at the production level determine the quality and effectiveness of the production system. Management focusing on people as the source of variation is indicative of an unstated assumption that the only source of mistakes is people. This does not encourage organisational learning. Without a systemic viewpoint that recognises the interdependencies among production results and the causes that lie elsewhere in the organisational system, managers will probably continue to focus on the front line workers. Front line workers often cannot do anything to correct the problems created elsewhere since they do not even have control over the operations they perform and they can not see the connections between other functional activities in the production processes. This often happens as a result of managers treating workers as organs and themselves as the brain of the organisation.

2.4.2 METHOD FOR THE INTERPRETATION OF VARIATION

In learning to use new concepts and methods for improvement the following systemic guidance may be followed by the individual or members of the team involved.

Figure 2-3 illustrates the elements of the systematic method of improvement.

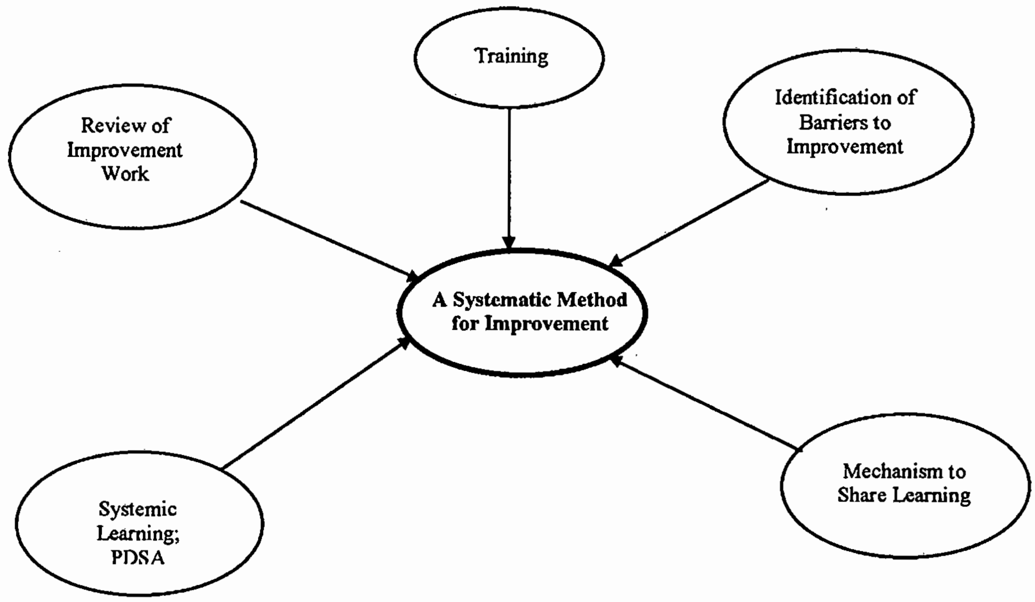


Figure 2-3: A SYSTEMATIC METHOD FOR IMPROVEMENT

▫ TRAINING AND GUIDANCE

Training and guidance in the use of tools and techniques such as Statistical Process Control for improvement should be provided to organisational members. The ability to provide Statistical Process Control training requires that a plan for developing and deploying qualified trainers must be put in place.

▫ IDENTIFICATION OF BARRIERS TO IMPROVEMENT

In identification of barriers to improvement, managers must learn about organisational policies and practices that hamper the ability to improve. Organisational members need to be convinced that they will not be punished for honest, open discussion of organisational problems.

▫ REVIEW OF IMPROVEMENT

Review of improvement of work serves a variety of purposes such as people gaining recognition for their work and provision of support for managers as developers of people.

Adoption of such a process requires conditions such as;

i. Understanding the concepts and methods for process and system improvement by managers.

ii. Management changing their role as judges to participants in improvement and development programmes.

▫ MECHANISM TO SHARE LEARNING

The mechanism to share learning across the organisation depends on what is considered suitable for its survival. Some organisations use meetings, others use newsletters. ADE for uses newsletters as a mechanism to share learning.

▫ SYSTEMATIC LEARNING (PLAN-DO-CHECK-ACT)

Systematic learning: plan-do-check-act, which was elaborated by Deming (1982), is designed to improve the efficiency and rate of learning. The first phase of the cycle is to plan, which describes a study to be conducted, or a test of a process change. In the next phase that is the do phase, any test carried out is recorded which will be the source of information for the check or study phase. In the check phase the results of the do phase are compared to predictions made during the plan phase. If there is deviation between the prediction and the result the theory used in the plan phase is revised till the expected results are obtained.

The act phase is where decisions are made on what actions should be taken based on the result of the three previous phases.

Knowledge of the concept of variation and use of appropriate methods to unravel the messages contained in variation increases the ability to learn. Variation can be detected and controlled through the effective utilisation of Statistical Process Control tools. This method allows operators to detect deviations in a measured value and then adjust the process back to get the target dimension (single-loop learning).

CONCLUSION

The chapter has reviewed Statistical Process Control tools as well as the benefits if properly institutionalised in an organisation. The fully automated type of SPC is recommended in a world class manufacturing industry due to its advantage. Variation and its interpretation play an active role in the implementation of SPC as a quality management tool in organisation. If SPC data and charts are not analysed to ascertain the source and cause of variation in an operating systems then there will be no point in implementing it.

SPC is an easy to implement improvement programme in manufacturing companies. It is the author's opinion is that no improvement programme will give positive results as claimed by the experts if management implement it without critically understanding the consequence of such a programme in their organisation. *'The fact that it worked for company A does not necessarily mean it will work for company B using the same approach.'*

The next chapter explores organisational design and models that reveal why SPC may yield positive results in certain organisations and not in others.

PART TWO

DEVELOPING A PROBLEM STATEMENT

This part of the thesis is the development of a problem statement for which this work strives to find a solution.

The problem statement in this work is developed with various tools and methodologies that are available to the author. These tools and methodologies include the Soft Systems Methodology (SSM), the Multiple Perspectives (MP), and others that are dealt with in depth in this part of the work. These tools and methodologies were used in analysing the situation at Atlantis Diesel Engines (ADE) from which a problem statement was then formulated. To this end the theories of organisational models were reviewed and comparisons made between the ideal case and the real case at ADE.

The author identified the problems encountered at ADE with regard to the implementation of SPC. It was also established that the approach used in the planning and implementation of SPC as an improvement programme was not proper.

CHAPTER THREE
ORGANISATIONAL DESIGN AND MODEL

Four types of organisational design and models are discussed in this chapter with particular emphasis on the systems and the cybernetic models. These two models are discussed in depth as they proved to be efficient and effective in addressing prominent issues such as interaction and communications within functions in organisations in a dynamic business environment. These issues emerge as part of the issues concerned with the failure of SPC at ADE. The organisational design and model on the author's point of view plays an important role in organisations embarking on the implementation of SPC and other improvement programmes. Communication between functions, allocation of resources and commitment on the part of employees are factors that massively depend on the type of organisational design and model.

3.1 WORLD VIEW OF ORGANISATIONS

The worldview of organisations has been changing as a result of the changing era. Organisations were seen as machines (Mechanistic) then as organisms (Organismic) and presently are as visualised social system.

3.1.1 THE MECHANISTIC VIEW OF ORGANISATIONS

Ackoff (1984) describes the mechanistic model of an enterprise as: "*A hermetically sealed clock, made up of purposeless and passive parts that operates predictably. Any deviation from regularity is reacted to with changes that restore it. The system is believe to tend in the long run towards a static equilibrium.*"

In the mechanistic model of an enterprise people and machines were organised in sequences and networks of tasks. People were considered and treated as machine parts that can be replaced or abandoned any time they malfunction. The more machines were used as substitute for human beings, the more people were made to behave like machines which resulted in dehumanisation of the work done by people (Ackoff, 1994, pp.7).

Ackoff further states that organisations were initially thought of as machines created by their gods, that is their owners, to do their work. Mechanistic organisations had no purposes on their own but only served the purposes of the owners. The people involved in this type of organisations were not expected to think about what they do but just to '*do as you are told.*' The mechanistic model of an organisation describes an organisation as a system without an environment. With the increasing level of education of workers and the intervention of regulatory bodies, the conception of an organisation as a machine faded out and gave way to an organismic model. Another reason for the transformation process was the high capital involved in running businesses, which forced sole owners to accept other investors as partners of the business. The mechanistic model, which is '*state maintaining*', as it attempts to maintain its state in the course of any change in environmental conditions, could not survive this transformation.

3.1.2 ORGANISATIONS AS ORGANISMS

Ackoff argues that the survival of organisations is a biological concept rather than a mechanical one. In the organismic model individuals (employees) are considered to be organs and senior level managers as the brain of the organisations. Most organisations these days still follow the principles of the organismic model of an enterprise. However relevant the functions of the workers, their interest and purposes are not considered to be an appropriate concern of the employers in this model (Ackoff, 1994, pp.12).

Ackoff uses the analogy of a motor car for the mechanistic model and a horse for the organistic model. "A horse, unlike a motor car, cannot be driven into a wall without compulsion" (Ackoff, 1984, pp.6). For organisations to survive, Ackoff proposed that workers should not be treated as replaceable machine parts but as living beings with purposes of their own. The organismic model is '*self maintaining*' and its responds to change in the environment is based on previously learned experience.

The emanation of protest groups both inside and outside organisations led to the emergence a new model of enterprise known as the social system model.

3.1.3 ORGANISATIONS AS SOCIAL SYSTEMS

The social system model takes into consideration the concerns, interests, and objectives of the people who are part of the system and the larger system that contain them. Unlike the mechanistic and the organismic models the social systems have purposes of their own and are made up of parts that also have purposes of their own (Ackoff, 1994, pp.16).

Many organisations these days claim to be modeled as a social system, which is not the case since some of their policies and goals are contrary Ackoff's definition of a social system.

3.2 THEORY OF ORGANISATIONAL MODELS

Jackson (1990) proposes four important models in organisation theory. These are:

i. Traditional or rational model;
ii. Human relation model;
iii. Systems model ;
iv. Cybernetic model.

All the models mentioned above have some degree of weakness in a certain aspect. However, the cybernetic and the systems models address most usefully many of the issues concerning communication and effectiveness that organisations are facing in the current business environment.

Some of the shortfalls of the organisational models were identified and elaborated on in the next section of this work.

3.2.1 TRADITIONAL OR RATIONAL MODEL

The traditional or rational model is often referred to as a 'mechanistic model' neglecting the interrelationship and interdependencies of the subsystems of the organisation. Due to its mechanistic nature it neglects the constraints imposed by the environment in which the organisation operates. Only the goals and objectives of the founders of the organisation are pursued by its members. This model does not provide remedy for weakness or any guide to improving organisational effectiveness. Ackoff (1994) in his work on organisational models described such organisations as mechanistic organisations.

3.2.2 HUMAN RELATION MODEL

The human relation model's inadequacies are based on the fact that human beings have fundamental social and self-actualising needs that must be satisfied at work has been questioned. Organisations see human needs as numerous and variable, many of them able to be dealt with outside the working environment. Although an organisation may be prepared to satisfy the needs of its people, it also has to take into consideration the reasons for its existence, which often run parallel with requirements for satisfying its people. This model does not address the design of efficient and effective information systems and issues concerning their relationships with their environment.

3.2.3 SYSTEMS MODEL

The systems approach looks at an organisation as a system made up of parts that are interconnected, interrelated and interdependent for efficient and effective functioning of the system. This section of the work answers the question '*Why managers need the systems approach for effective management?*'

System approach is a powerful methodology that can be used to explore the detail of an organisation. A system is made up of parts that interact with each other to function as a whole, and may be defined as a goal-driven group of interrelated activities linked by means of a network or structure. Systemic thinking is integrative, synthesising diverse viewpoints in other to understand the organisations as a whole. Systems approach entails structural thinking that focuses on the structure of the interrelationships among organisation parts. - Manufacturing, Finance, and Marketing business units. Most systems we deal with are subsystems of larger systems (recursion levels). The complexity of a system depends on the number of subsystems involved in forming the whole.

For example, at ADE the crank line is a subsystem of the crank cell, which in turn is a subsystem of the manufacturing business unit. The manufacturing business unit is a subsystem of the bigger system ADE which itself is a subsystem of the environment in which it the organisation, operates.

The systems approach basically addresses issues such as:

- Understanding our business environment better.
- Being more alert to forthcoming changes.
- Sharing and utilising information effectively.
- Taking initiative to continuously improve our skills and position.

The viability of any system depends on the way information is channeled and disseminated in the system as a whole. Effective communication can be achieved with the help of effective feedback loops. The feedback loops channel information about the output of the system to the input side of the system, so that any gap between the actual and expected results can detected and be dealt with. The world around us is full of change. Any system that is going to survive long enough to be an important part of our environment has to have the ability to cope with that rapid change. The ability of a system to be self-stabilising is a function of its negative feed back loops which is a priority in the systems approach.

3.2.3.1 THE ORGANISATION AS A COMPLEX SYSTEM OPEN SYSTEM

A system is considered complex if it is; self-stabilising, goal-seeking, program-follower, self-reprogramming, anticipating, environment-modifying, self-replicating, self-maintaining and repairing, self-reorganising and self-programming. Managers frequently encounter many problems as they are involved in or are in contact with complex systems. The best rule of thumb for complex systems is to make decisions at the lowest possible level, but be ready to shift the control of the situation to a higher level if serious problems occur. The flexibility that enables complex systems to survive in rapidly changing situations also results in a loss of predictability.

Organisations can be studied and diagnosed as an open complex system. The open system approach provides systems practitioners/analysts with an abstract model that is applicable to any kind of organisations as well as business units, cells or departments within them.

In diagnosing an organisation as an open system the elements listed below are to be identified for the system identification and familiarisation.

- Input (or resources) - This includes the raw materials, human and financial resources that the organisation obtains from the environment and that contributes to the transformation process.
- Outputs - This includes the products, services and ideas that are the outcome of the organisations' action based on the transformation process. A high proportion of the output of the organisations is transferred back to the environment and uses others internally.
- Transformation - This includes methods and processes for transforming or changing resources into outputs.
- Environment - The environment includes all external organisations and conditions that are directly related to/or can influence the organisation's main operations. The success of an organisation depends heavily on its ability to adapt to its environment.
- Purposes - This includes strategies, goals, plans, and interest of the organisations' dominant decision-makers.
- Behaviour and processes - These are the prevailing pattern of behaviour, interactions, and relationships between groups and individuals (stakeholders).
- Culture - This includes shared norms, beliefs, values, symbols, and rituals relating to key aspects of organisations' life, such as the nature and identity of the organisations.

- Structure - This includes enduring relations between individuals, groups, and larger units-including role assignments (job descriptions, authority, responsibility); standard operating procedures; human resources mechanisms.

The interaction of these elements is illustrated in Figure 3-1.

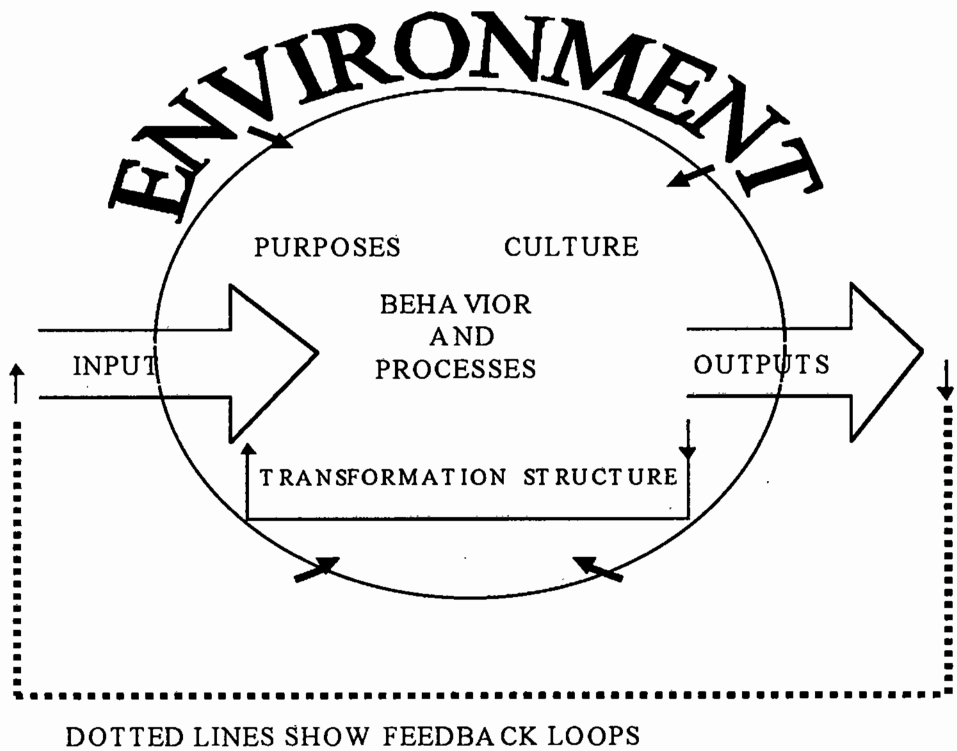


Figure 3-1: OPEN SYSTEM MODEL

Developing a systemic view of an organisation and understanding of the structures that determine its behaviour will significantly improve the probability of the long-term success of any program an organisation may embark on.

3.2.3.2 CRITICISMS OF THE SYSTEMS APPROACH

Although the systems model recognised and examined most of the important characteristics of organisations it may however be misleading in that:

- It sees survival rather than goal-attainment as the basic *raison d'être* of organisations.

- It overemphasises the interdependence of parts and the functional relationship of the parts to the whole but is silent on the measure of performance of an organisation in achieving its goals.

3.2.4 CYBERNETIC MODEL

The cybernetic model is a superior model for guiding managers in improving the efficiency and effectiveness of their organisations.

The model has to be capable of:

- being applied to a wide range of organisations, large and small;
- dealing with 'multi-organisations' which have relatively independent parts;
- capturing interdependence of the subsystems of those parts;
- revealing the source of command and control in the organisation;
- providing the basis for the design of information systems;
- representing the system in the dynamic interrelationship with its environment;
- suggesting reasons for organisational success or failure and having at hand remedies for poor performance and explanations as to why such remedies should be adopted.

Cybernetics in Stafford Beer's (1981) terms is '*the science of effective organisation.*' To understand an organisation, it is necessary to identify the various components of it and using the system approach. Cybernetics then relates to systems that are complex, dynamic, probabilistic, integral and open. In section 3.2.3.1 the author elaborated on complex and open systems and how organisations are viewed and diagnosed as complex and open systems. The cybernetics laws govern the cybernetic model.

3.2.4.1 THE CYBERNETICS LAWS

There are three laws of cybernetics which managers or cyberneticians can use to gain explanation for organisational behaviour and change (Clemson, 1984, pp.39).

SELF ORGANISING SYSTEMS LAW (Law 1)

Complex systems organise themselves; the characteristic structural and behavioural patterns in a complex system are primarily a result of interaction among the system parts. A complex system has basins of stability separated by thresholds of instability.

FEEDBACK LAW (Law 2)

The output of a complex system is dominated by the feedback, and within wide variations the input is irrelevant. All outputs that are important to the system will have associated feedback loops. System without the appropriate feedback mechanism will be defective and will not achieve the desired effect.

For a system to function properly it requires circular causality, meaning feedback is provided to all parts of a system and cause and effect is accepted for all parts of the system.

There are two types of feedback systems: positive and negative feedback systems. Positive feedback brings about exploding change, whereas negative feedback is a balancing loop that brings about goal-orientated change. Effective management requires managers who employ feedback as a way of information management. Variability can be identified, studied and eliminated through the use of feedback systems.

LAW OF REQUISITE VARIETY (Law 3)

Given a system and some regulator of that system, the amount of regulation attainable is absolutely limited by the variety of the regulator.

Most of the regulation of very complex systems is achieved through interaction of parts, that is one part acts to regulate some other part.

In other words the degree of regulation achievable is limited by the complexity of the regulator compared to the complexity of the system to be regulated. This law argues that managers are always faced with a situation in which it is not possible to achieve complete regulation and it demonstrates the theoretical impossibility of achieving complete regulation. One of the practical implications of the law of requisite variety is 'working to the rules'.

3.2.4.2 CYBERNETICS QUESTIONS

Cybernetics questions as argued by Clemson provide a powerful beginning for analysing a complex social system and a helpful guide to action in reforming these situations (Clemson, 1984, pp.66). These questions are as follows:

i. What is the system? What are the relevant boundaries? What is the relevant environment? - (system definition)
ii. What is the real purpose of the system? What purpose of the system might we infer if we looked at what the system is actually doing rather than thinking about the rhetoric on purposes? What purpose would we like the system to have? - (purpose)
iii. What are the constraints on the system? - (constraints)
iv. What is the language used for thinking about the system? - (meta-language)
v. How does the system work? - (dynamics)
vi. What are the outputs that the rest of the system requires of your system? - (required outputs)
vii. What self-organising tendencies does the system have? - (self-organising)

The answers to these questions give an idea of the effectiveness and efficiency of an organisation.

3.2.4.3 THE VIABLE SYSTEM MODEL (VSM)

Stafford Beer's (1981) Viable Systems Model is a cybernetic model that has been developed and can be applied at all levels of the organisation to learn, adapt and improve its overall efficiency and effectiveness. The VSM is a neuro-cybernetic model of organisations that focuses on mechanisms required in facilitating and promoting the maintenance of the organisation's systems identity or viability through the support of structure, process, and function. In terms of viability the major responsibility of the organisation is seen as the balance between the stable interaction of the internal and the external environment in which the organisation operates.

The VSM was designed to illustrate an effective organisation. It consists of five functional elements – implementation (S1), co-ordination (S2), control (S3), intelligence (S4) and policy (S5), which must exist for the organisation to be viable and develop long-range effectiveness. The VSM explores the interactions between an operation, the environment in which it takes place, management of that operation and the mental models held by management.

THE PHILOSOPHY OF THE VSM

The underlying philosophy of the VSM relates to the need to deal with change such as:

- Organisations are continually confronted with increasing levels of complexity, causing problems characterised by interdependency.
- Technological advances are being incorporated into areas of management, which is requiring new approaches to deal with increasing complexity where the traditional management models are inadequate.
- Fundamental to all organisations is the concern for control: the VSM provides a superior control model derived from the cybernetic principles that are appropriate for application to all types of systems and organisation.
- Organisations exist within a changing environment that makes it practically difficult and often impossible to achieve the set goals. In order to overcome this difficulty an organisation need a mechanism to facilitate its understanding of both the internal and external environment.

ELEMENTS OF THE VSM MODEL

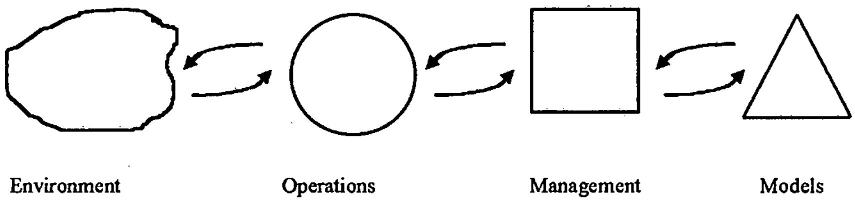


Figure 3-2: OPERATIONAL UNITS OF THE CYBERNETIC MODEL

The VSM is not an organisational structure but a tool to examine aspects of an organisation at all recursion levels. Its strength is that it is possible to identify all the relevant parts of an organisation and to see how businesses work and exist.

As the VSM model is relevant to all levels of the organisation it can be used recursively. At each level the same basic elements of the system are evident. The detailed functions of the elements at different recursive levels are mostly different in that they become more specific the deeper the system is explored.

SYSTEMS FUNCTION IN THE VSM

- **SYSTEM ONE (S1)**

The system 1 (S1) function of the organisation consists of the various parts concerned with the implementation of the task(s) that the organisation is supposed to be doing. The particular task depends on the level of recursion.

Each part or function has its own environment and its own relations with the outside world (environment), interacts with the other subsidiaries and has its own localised management (depending on the level of recursion) embedded in a larger management system. An organisation could have more than one S1 function depending on its objectives. These operating systems which produce or deliver the value-adding goods or services are the S1 functions. The workstations in the operational system, which must be viable, are called System One.

In the case of ADE if the system in focus is the manufacturing business unit, then the S1 functions are the operation functions in the various cells. If the system in focus (R1) is the crank cell, and then the S1 functions are the crank operations function in the crank line-I, crank line-II, conrod- and camshaft-lines.

▫ SYSTEM TWO (S2)

The system 2 is a co-ordination function, which ensure that the various parts of the system 1 of an organisation act in harmony. System 2 consists of the control centers of the parts of system 1 linked to a 'corporate regulatory center'. The function of this system is to co-ordinate the operational functions to meet current needs. System two is a system of individual rules and behaviour for co-ordinating sub-operations in term of current needs. System 2 must enable the various units of System Ones to solve their own problems, that is, to decentralise decisions. System two activities include production co-ordination, scheduling, planning cycle, frequency of meeting, and formal meeting.

In the case of ADE subsidiaries a, b, c, d as shown in figure 5-4 all play a part in manufacturing the firm's major product (Diesel Engines); the outputs from crank-lineI, crank-lineII, cam-line and the Conrod-lineI are part of the parts needed by the plant for the assembly of the complete diesel engines.

In situations where something goes wrong with the production system such as non-conformance to specification on the crank-line, the S2 function intervenes to bring the system to a stable state. Local management for the various cells need to be informed especially those who depend on the crank-line for their inputs and those who supply the crank-line with their inputs in order to adjust their operations. Certainly, this is likely to send trouble reverberating throughout the system creating violent oscillations in the crank-line.

▫ SYSTEM THREE (S3)

System 3 is a control function. It does not initiate policy but interprets it in the light of internal data from systems 2 and 3*, and external data from system 4. It is responsible for passing coordinated plans down the line to system 1. System 3 must oversee and monitor the effective implementation of policy and distribution of resources to the parts of system 1. In order to achieve this it has to monitor and control the performance of system 1, taking control action in accordance with information it receives up the information channel from the local operation management function, and also from system 2 and system 3*.

There should be two-way communication between System 3 and System 1 for the organisation to work effectively. There is also an audit function labeled S3*, which tests that the output of the operation is within acceptable range. S3 is the channel for orders within the organisation. This system represents the lines used in the traditional organisation chart. S3 may be referred to as the management of the existing operations within the separate System Ones.

- **SYSTEM 3* (3*)**

The system 3* is an 'audit channel' that gives system 3 direct access to the state of affairs in the operational elements. Through the S3*, S3 can get immediate information rather than relying on information passed to it by the localised management of the divisions or cells. The S3 might want to check directly on quality and that other production procedures are being followed. Three kinds of information systems converge on S3. These information systems comes from the auditing channel (S3*), the co-ordination function (S2), and the local management of S1 functions, respectively.

S3 has the overall responsibility for the day to day running of the organisation. It tries to best carry out the policy of system 5, implementing it with maximum effectiveness and efficiency.

In summary system 3 is therefore:

- a control function and ultimately tries to maintain internal stability;
- interprets policy decisions of higher management;
- allocates resources to part of system 1;
- ensures effective implementation of policy.

There is an S3* function present at all levels of recursion at ADE. The question of interest is 'if there are S3* functions present at all level, why are control functions not efficient and effective?'

In the case of ADE there is a 30 minutes daily meeting of all the facilitators in the crank cell with the cell manager in the morning. This meeting is called *'feedback'* meeting. The purpose of this meeting is feeding back on the progress made in solving previous problems that have been assigned to people to be dealt with and the progress of operations, as well as new problems that needs attention.

- **SYSTEM FOUR (S4)**

System 4 is the developing function of the organisation. Beer refers it to as the intelligent function of the organisation. It has two main tasks. First it acts as the biggest '*switch*' in the organisation. It switches instructions down from the '*thinking chamber*' (system 5) of the organisation to the lower level systems. It also switches upwards, from systems 1 and 3, information required by systems 5 to take major strategic decisions.

The second major task is to capture for the organisation all relevant information about its total environment. For the organisation to be viable and effective it needs to match the variety of the environment in which it operates. The System 4 must have a model of the environment which enables predictions to be made about the likely future state of the environment and makes provision to respond to changes on time in order to gain competitive edge and stay in business.

System 4 brings together internal and external information in an 'operation room' where this information is analysed for strategic decision making. It serves as a channel for transmission of urgent information from Systems1-3 to System 5. Through interaction and learning, the System 4 gather information on what the weaknesses of the organisation are and *what* advantage(s) their competitors have over them and *why*.

The R&D and project management teams are intelligent functions; they study the environment to continuously improve the already existing products of the organisation. With a close and rigorous analysis of SPC data and charts system 4 function can develop products serving the same purposes as the existing products but with a cut down of material cost by trying to close the control limits of the control chart. The System 4 must understand the improvement programs properly before informing System 5 what to consider in the future plans and strategy. System 4 must understand how new programs work in a specific environment and tailor any new program the organisation is about to implement to suit their own environment. It also needs to channel information to system 3 about any new program and how it needs to be implemented and controlled.

The system 4 function is concerned with the external and the future. It deals with threats and opportunities and analyses input from the environment. This function has a major role to play for the organisation to be competitive and survive in the dynamic business environment.

- **SYSTEM FIVE (S5)**

System 5 is responsible for the direction of the whole enterprise (brain). It formulates policy on the basis of all the available information passed to it by System 4 and communicates the policy downward to System 3 for implementation by the other divisions or cells. System 5 ensures that the organisation as a whole adapts to the external environment while maintaining a degree of internal stability. System 5 also represents the essential qualities of the 'whole system' to any 'wider system' of which it is part.
The system 5 is also responsible for setting the policy of the organisation and with the flow of information from the system 4 function programs are implemented. System 5 balances current activities (system 3) against future need (system 4).

3.2.4.4 CRITICISMS OF THE CYBERNETIC MODEL

There have been criticisms of the cybernetic model, categorised under methodological, epistemological, and utility of the model.

i. The model is accused of adherence to misplaced mechanical and biological analogy.
ii. The concept of 'variety' has been criticised as a poor measure inappropriate for scientific work and not much can be realised when applied to the management of social system.
iii. It gives an impoverished picture of organisations.
iv. It is held to emphasise stability at the expense of change and difficult to apply in practice.

CONCLUSION

As discussed above organisational models play a major role in organisational effectiveness. The type of models discussed here have both advantages and disadvantages but the cybernetic and the system models were considered appropriate for organisations embarking on improvement programmes. Considering organisations as a system with interdependent and interrelated parts communication improves. An ideal cybernetic model addresses issues concerning coordination, implementation, control & auditing, intelligence and policy in organisation through the systems functions (S1-S5).

The next chapter looks at the situation at ADE having the knowledge of organisational design and model.

CHAPTER FOUR
ANALYSIS OF THE SITUATION AT ADE

This chapter discusses the tools and methodology used to uncover the problematic situation of the case study (Atlantis Diesel Engines) and thereafter to develop a problem statement. Understanding the situation of the case study is the foundation stone of the problem statement. Ryan (1995) proposed an inquiry framework known as by the acronym SCQARE (S-Situation, C-Concern, Q-Question, A-Answer, R-Reasoning, and E-Evaluation). SCQARE was used in collaboration with the Soft Systems Methodology (SSM), Multiple Perspectives (MP) approach, Viable Systems Model (VSM) and others to get an insight into the situation and then came up with concerns from which a problem statement can be formulated.
Systemic methodologies such as SSM, MP, and VSM were used in this work. The reason was that through the systemic point of view an inquirer gets a helicopter view of a problematic situation.
The purpose of this chapter is to identify the concerns arising from the problematic situation at ADE.

4.1 BACKGROUND TO ADE

Atlantis Diesel Engines (ADE) is a manufacturer, assembler and distributor of diesel engines and spare parts for diesel engines for automotive, agricultural and industrial sectors. ADE was a state-owned industry that enjoyed protection from the government through the regulation of importation of diesel engines into South Africa. This protection made ADE the sole competitor for the market of diesel engines in South Africa.
Although, quality, cost, and delivery were taken into consideration in strategic planning, these were not pressing issues, as they should have been if ADE had been competing with other world class manufacturing companies in the same industry. In the new South Africa, where the market is open to competitors from all over the world, ADE has lost most of its local customers due to overseas competitors. The entrance of overseas competitors into the South African market posed an initial threat to ADE but at the same time created new opportunities for ADE to penetrate the international market.

The competitiveness in the automotive industry brought about a drastic organisational restructuring, redesigning of the old processes, and introduction of new processes and technology. Having realised the competition the organisation is currently facing, ADE opened itself to strategic investors such as Mercedes Benz of Germany, Perkins in the UK and others who are now stakeholders. This move has given ADE the opportunity to compete with the world class manufacturers in the automotive industry. The main shareholder is the Industrial Development Corporation – IDC.

The acquisition of ISO 9000 certification in 1993 has given ADE the edge to compete worldwide, with customers including:

- Mercedes Benz AG (Germany, Brazil, Turkey)
- Perkins UK
- Ssanyong (South Korea)
- Daewoo (South Korea)
- Detroit Diesel Corp. (USA)

Most manufacturing organisations, even though they may not be a world class manufacturing industry, see the acquisition of ISO 9000 as a market ploy.

There are three type of working shifts at ADE; this is subject to change due to varying demand from the customers.

i. Multi-shift
ii. Double-shift
iii. Straight-shift

At the period of this research ADE were operating three shifts, 6 days per week, due to the demand of the overseas customers (the Cuban project where they have to supply Cuba with 10,000 diesel engines in the next three years).

Currently there are 1841 hourly paid workers and 300 monthly paid workers of which approximately 35% of the hourly employees and 20% of the monthly paid employees are unionised. There are four forums for expressing grievances and listening to the views of the employees but none of the forums allow all employees to meet face to face with top management of the organisations.

The ratio of non-whites to whites in management positions is creating a great deal of tension in the organisation as some of the non-white employees' think they have the capabilities of carrying out managerial responsibilities. Management has expressed their desire to increase the ratio of non-white managers, which is also of the main concerns of the non-white employees, who are mainly the shopfloor workers, and form the majority of the staff.

There are programs (vision 2000) in place to increase the ratio of the non-white management to 30% by the year 2000.

4.1.1 STRUCTURE OF THE COMPANY

ADE is made up of three business units: Trading and Marketing, Manufacturing, and Assembly. Figure 4-1 illustrates the basic organisational structure of the company. There are three senior general managers heading the three business units who report directly to the Managing Director. Supporting the general managers are the cell managers who are responsible for the running of the individual cells within the business unit. Within each cell are production lines, which are managed by facilitators under the auspices of the team leaders. Appendix A depicts the detailed organisational structure of ADE.

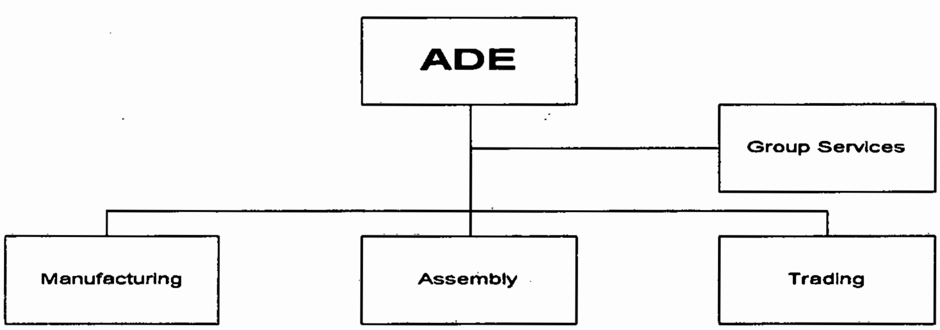


Figure 4-1: BASIC ORGANISATIONAL STRUCTURE OF ADE

4.2 THE USE OF SOFT SYSTEM METHODOLOGY (SSM) AND MULTIPLE PERSPECTIVES (MP) APPROACH IN INQUIRING INTO THE SITUATION AT ADE

With the research focusing on Statistical Process Control in the manufacturing business unit, specifically the crank cell, the SSM was geared towards getting information relevant to SPC in the crank cell, not the overall problems in the organisations.

ADE has two crankshaft lines, one camshaft line, and one conrod line which produces for both assembly and component purposes. Research and survey indicate that the crankshaft business is booming and needs further attention and focus. One of the concerns of top management is to meet the current demand of the customers as production is often behind schedule, and one reason for such a delay is the problem arising from lack of quality products as a result of rejects and rework.

4.2.1 SITUATION EXPLORATION BY INTERACTIONS AND INTERVIEWS

The situation at ADE crank cell may be explored using the Soft System Methodology (SSM) and Multiple Perspective approach.

4.2.1.1 SOFT SYSTEM METHODOLOGY

According to Checkland (1990) SSM, if thoroughly and properly used may help managers of all kinds and at all levels to cope with their task. SSM is a methodology based on systems thinking and can be used to tackle chaotic situations in the real world. Appendix B illustrates the detail and step-by-step description of the SSM.

SSM was used to gather data from employees at different levels in the organisation's hierarchy. The situation concerned with a particular problem or which arises due to a particular problem may be perceived differently by employees at different levels in the organisation hierarchy. Since people look at the same situation from different angles and therefore different perceptions (different mental models). Therefore to get the relevant information or data, the SSM was performed on employees of different level on the organisational ladder; the top management, middle management, team leaders, and shopfloor workers.

The data collected were contradictory in some cases as each group tried to protect their image and rights by covering up their respective weaknesses. There were also other issues that came to the notice of the researcher after spending some time in the organisation under investigation.

The Systems questions in appendix C compiled by Srumpfer (1990) in collaboration with the Multiple Perspective approach were used as guideline for the interviews at ADE. Most of the questions were not answered, apparently because nobody was willing to claim responsibility for what seemed to be done incorrectly in the crank cell.

4.2.1.2 THE MULTIPLE PERSPECTIVE APPROACH

The multiple perspective approach consists of three perspectives:

- Technical perspective (T);
- Organisational or societal perspective (O); and
- Personal or individual perspective (P).

These perspectives may enable managers who are practitioners of the systems approach to bridge the gap between analysis of and action on any undesirable situation they encounter in their operations. The gap can be bridged by management on the basis of different views of a particular situation through the three different perspectives, T-O-P, before any strategic decisions are made. T-O-P perspectives present insight into a particular situation, which are not obtainable with the other approaches.

Multiple perspective approach removes the effect of the biased and subjective views held by people which are based on their experience and beliefs as well as their position and level of responsibility. T-O-P perspectives enable managers to distinguish *how* and *what* they are looking at since different perspectives represent very different sets of underlying axioms.

In employing Multiple Perspective approach to get insight of a given situation the following points are to be considered (Linstone, 1989, pp.312).

- Any complex problem may be viewed from any perspective. That is there is no specific rule or logical sequence of using any of the three perspectives.
- There is no proof for a right set of perspectives for a particular situation.
- Two perspectives may reinforce each other or cancel each other out; they frequently "cross-cue" each other.
- In real-life situations problem management consist of three activities such as:
    i. Finding paths- that is what attributing to the causes and sources problem (why SPC is not adding the value expected).
    ii. Decisions - what really needs to be done to address the problem at hand (what organisations have to put in place to harness the viability of SPC as a quality management tool).
    iii. Implementation - how to execute the plan of action based on the decision made to address the situation.

The T perspective focuses most strongly on a decision (i) and least on (iii); hence the "gap" between analysis and action. Implementation on the other hand depends first and foremost on the human resources, and this makes O and P become crucial as one moves from (i) to (iii).

Linstone (1989) argues that organisations spend most of their time on T-perspective (90%) and about 10% on O and P. One important way of getting O and P perspectives is by the use of interviews. Employing the three perspectives normally brings about different views often conflicting with each other. However conflicting the three perspectives may be they ought all to considered on the same level in the decision making process. Various perspectives may not, and do not impact each other. The justification for the use of multiple perspectives is twofold:

i. Each perspective yields insight not obtainable with each other, and
ii. The O and P perspectives are essential in bridging the gap between analysis and action.

The Multiple Perspective approach gives a three-dimensional view, rather than the one-dimensional (T) view, of the real world system.

4.2.1.3 DATA COLLECTED FROM THE USE OF SSM AND MP

The Soft Systems Methodology and Multiple Perspective approach were used on some employees from all the levels on the organisational hierarchy and the following data was collected.

- ***SHOPFLOOR WORKERS***

Shopfloor workers feel that management is not doing its best to change the racial composition of management. They claim management is basically made up of whites. The shopfloor workers have a belief that nothing good can be done while people of different race take decisions affecting their welfare. This brings about the *'we-they'* attitude toward whatever activity goes on in the organisations. Workers are hired as casual worker for some time and after in-house job training they are confirmed as contract workers. Contract workers do not involve themselves in unions since they feel there is no job security for them.

The shopfloor workers are the people involved in the basic operations on the shopfloor where the SPC is installed. The majority of shopfloor workers claim that they do not really know the importance of Statistical Process Control (SPC) and its contribution to their daily task. Concerns surfaced that SPC would target whoever *'isn't doing his job'* and management may use the data it to access their performance in case of retrenchment. They also see SPC as a trap set by management to blame them for situations over which they have no control.

- *TEAM LEADERS*

Team leaders meet with their working group for 10-15 minutes before the start of every shift. Jobs are assigned and distributed at these meetings and provisions made for any absenteeism.

There exists a strong family and team spirit at the shopfloor between floor worker and team leaders. Team leaders see middle management (facilitators) as submissive, and always agreeing to whatever top management proposes no matter what it takes to achieve them.

Team leaders see SPC as a formality that management uses to gather data the results of which are not used to improve the existing processes. They do not really worry if the SPC charts are properly filled out at the right time. If asked why the SPC charts are not properly filled or not filled at all, their response is '*this is not my job*'. This brings out the question of job responsibility and description.

- *MIDDLE MANAGEMENT*

There is poor two-way communication between middle management and shopfloor workers. Middle management relies on team leaders for their feedback, which at time can be detrimental. Not all middle managers know what SPC is really about and capable of doing in the production system. The few who believe they have roles to play to make quality a reality know what SPC is capable of, and what can be achieved from extensive use of SPC.

Most of the middle managers think SPC is only important when it comes to checking the conformance to standards of incoming materials from the suppliers, that is they consider SPC as an auditing tool to check suppliers.

The inserts are transcripts interview and comment from specific middle management personnel at ADE crank cell are depicted in appendix B.

- ***Top Management***

Top management claimed that they have made provisions for the implementation and utilisation of SPC. According to top management training and workshops have been provided for the employees to make good use of SPC and other statistical tools and techniques for improvement processes. They also claim further training will be provided if the need arises. One important thing management do not realise is that providing the necessary resources without their involvement and commitment does not guarantee success.

4.2.1.4 CATWOE ANALYSIS OF ADE

The analysis known as by the acronym CATWOE (see Table 4-1) as elaborated in appendix B. has been applied to the situation at ADE. The CATWOE was applied to the shopfloor workers and team leaders, middle management, and top management at ADE.

C-Customers	The victims or beneficiaries of T
A-Actors	Those who would do the T
T-Transformation process	The conversion of input to output
W- Weltanschauung	The worldview which makes this T meaningful in context
O-Owner(s)	Those who could stop T
E-Environmental constraints	Elements outside the system which takes as given

Table 4-1: THE CATWOE mnemonic (CHECKLAND, 1990)

SHOPFLOOR WORKERS AND TEAM LEADERS

- **Customer**

The shopfloor workers and team leaders are the people involved with the main operations (the S1 functions) of the organisations as proposed by Stafford Beer's (1981) Viable System Model (VSM). They see management as the beneficiary customers and themselves as the victims of the transformation process.

- **Actor(s)**

The actors are the machine operators, machine setters, maintenance workers, and the team leaders.

- **Transformation Process**

The raw materials for the transformation process are the final products from the foundry. These products pass through a series of processes or stages, where at each stage value is added and variability set. This variability needs to be removed at the beginning of the process if it is not to propagate into an uncontrollable state that will oscillate the system. SPC, as clearly specified in chapter two of this work is capable of removing variations if its full potential is utilised.

- **Weltanschauung**

They do what they are assigned to do without asking why, since their views are not taken into consideration in making decisions affecting their work.

- **Owner(s)**

Although the team leaders are in charge of the main operation on the shopfloor they have no authority to stop the process. It is the responsibility of facilitators and cell managers to stop the process. As described by Ackoff in his definition of organismic model of an organisation- management is regarded as the brain and workers as the organs.

- **Environmental constraints**

Workers do not have say in decisions such as:

- work and production scheduling;
- production target-whether it is feasible or not;
- quality of raw material;

MIDDLE MANAGEMENT

- **Customer**

There are two types of customers involved at this level, the internal and external customers. In most cases the external customers are the beneficiaries. The internal customers include shopfloor workers and top management. Middle management serves as the source of information for the top management and shopfloor workers. Information to shopfloor workers is often channelled through the team leaders who interact with the middle management. The shopfloor workers are often victimised for conditions and situations over which they have no control.

- **Actor(s)**

Facilitators, engineers, cell managers and some top managers.

- **Transformation Process**

The objective of the transformation process is to make the external customers happy by providing them with their needs (right on time, with the right quality).

- **Weltanschauung**

With their support the organisations can improve their position in the automobile industry.

- **Owner(s)**

Top managers.

- **Environmental constraints**

Despite inter cell meetings and interactions, the cells operates as independent entities which is contrary to what the systems approach proposes (interaction of parts to form a whole). This results in lack of common or shared vision on the part of the managers.

TOP MANAGEMENT

- **Customer**

The main beneficiaries of top management are the external customers. They are those who enjoy the final product of the organisations and those who provide support and other services. Middle management and shopfloor workers are internal customers. The middle management benefits to an extent compared to the shopfloor workers since they have direct channels of communication unlike the shopfloor people.

- **Actor(s)**

Senior managers and top management.

- **Transformation Process**

The organisation needs to survive and compete internationally with other organisations in the same business. The output is organisation strategy that will give a competitive advantage over other in the same business.

- **Weltanschauung**

The company can do better by introducing new technology and methodology employed by the leading competitors in the automobile industry.

- **Owner(s)**

Stakeholders and the government.

- **Environmental constraints**

Employees are not clear about the vision of the top management and how they expect their vision to become reality. This results from poor two-way communication.

In this research a problem statement is to be formulated based on the current situation and the concern of the employees and organisations as a whole. The Soft Systems

Methodology and the Multiple Perspectives give an insight or the helicopter view of the organisations under consideration.

4.3 CONCERNS FROM INTERVIEWS AND INTERACTIONS

From the interaction with the middle management, facilitators, and team leaders it was evident that the main concern centres on rejects and rework rates. The machines are modern. Routine checks are done on the line at regular intervals to monitor the production processes, but all the same the reject and rework rates are high compared to those of their overseas competitors. The high level of rework and reject in the crank cell results in delays in meeting the target for the shifts and as a result delivery delays.

4.4 QUESTIONS ARISING FROM THE CONCERNS

At this point in the research many questions surfaced, based on the situation at the ADE organisation. The questions, which need to be addressed at this stage, include:

i. Is SPC really adding value to the system under investigation?
ii. If SPC is not adding the expected value, then what is really going wrong?
iii. How can SPC add the value expected to the system?
iv. What is the source of the current undesirable situation?
v. Is the problem a social or/and technical problem?
vi. What can be done to bring the current undesirable situation to a desirable state?
vii. Is the SPC the right or/and the only technique or tool that can be used to address the current situation?
viii. What are the sources of conflict between the parts of system one (S1) and between them and the environment?
ix. What are the elements of systems two (S2) that have a harmonising or dampening effect?
x. How is the co-ordination function (S2) viewed in the crank cell?

xi. How does the control function (S3) allocate resources, ensure the effective implementation of policy, and at the same time carry out audits using the auditing channel?

xii. What are the system four (S4) activities in the crank cell?

Putting all these smaller questions together we come out with a simple but all round question which addresses the concerns of the of the researcher and the organisation (ADE). The question is *what can be done to harness the full potential of SPC at ADE?*

CONCLUSION

The use of the systems methodologies and tools has made it possible for the author to understand the situation at crank cell in Atlantis Diesel Engine. These methodologies however, may not reveal all the relevant information required for analysis purposes. Based on the data and information gathered the current problematic situation was studied and analysed and the concerns from different levels on the organisational hierarchy surfaced. From concerns erupted questions that need to be addressed to determine the reasons for the failure of SPC at ADE and other manufacturing industries.

The next chapter explores the diagnosis of ADE using the theories of systems and the cybernetic models described in the organisational design and model

CHAPTER FIVE
DIAGNOSING ADE USING THE THEORIES OF ORGANISATIONAL DESIGN AND MODEL

This chapter explores the description and diagnosis of ADE using the systems and the cybernetic models. The system under focus was the crank cell. Firstly, the interaction of parts in the manufacturing business unit was analysed using the systems approach. Secondly, manufacturing business unit and the crank cell were described and diagnosed using the cybernetic model. The aim of this chapter was to diagnose ADE using the two models and compare the findings to the ideal systems and cybernetic and looks for the shortfalls for redesigning of the system under focus for improvement.

5.1 SYSTEMIC VIEW OF ADE

In describing ADE using the systems model, firstly, the recursion level of the system in focus has to be identified.

Recursion (appendix D) in the systems under consideration for the research.

- R0 - Recursion level 0: the containing system, supra-system or environment - manufacturing business unit.
- R1 - Recursion level 1: the system in focus, or system of interest - the crank cell.
- R2 - Recursion level 2: the elements, parts, and/or subsystems of the system of interest R1 - the crank line operations.

Any level or unit within an organisation can be viewed as a system depending on the level of recursion. The systems approach model can be applied to the total organisation, or a major division or business unit within the organisations can also be viewed as a system having all of the elements and features mentioned in the description of a complex open system.

Figure 5-1 shows the different levels of recursion that the researcher considered for the purpose of this thesis.

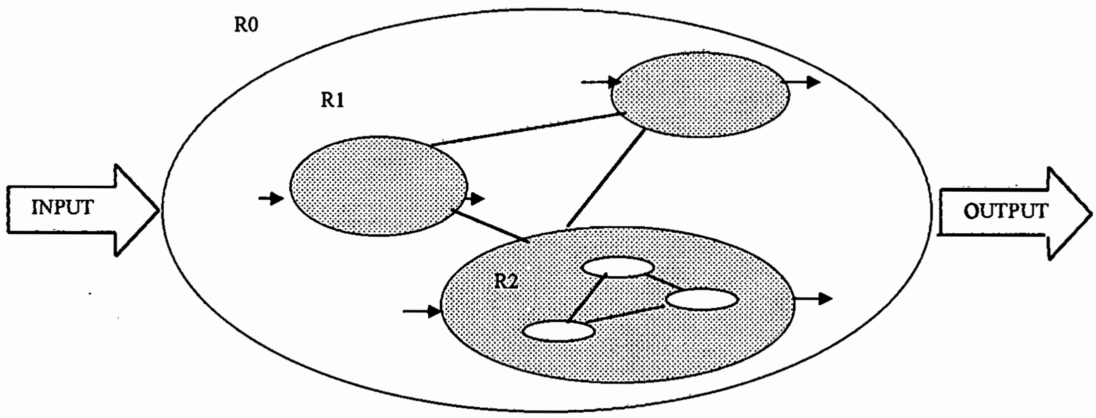


Figure 5-1-: RECURSION LEVEL OF ADE

5.1.1 THE INTERACTION OF PARTS IN THE MANUFACTURING BUSINESS UNIT

The manufacturing business unit in ADE is made up of nine main subunits or cells;

- Crank
- Block
- Pipes & Miscellaneous
- Foundry & Marketing
- Manufacturing Engineering
- Quality Assurance & Product Services
- Tool & Core
- Moulding & Melting
- Finishing & Customer Services

These units are interrelated and interdependent which together as a whole contribute in the production of the final product of the organisation.

The interaction of the various parts in the manufacturing business unit is shown in figure 5-2.

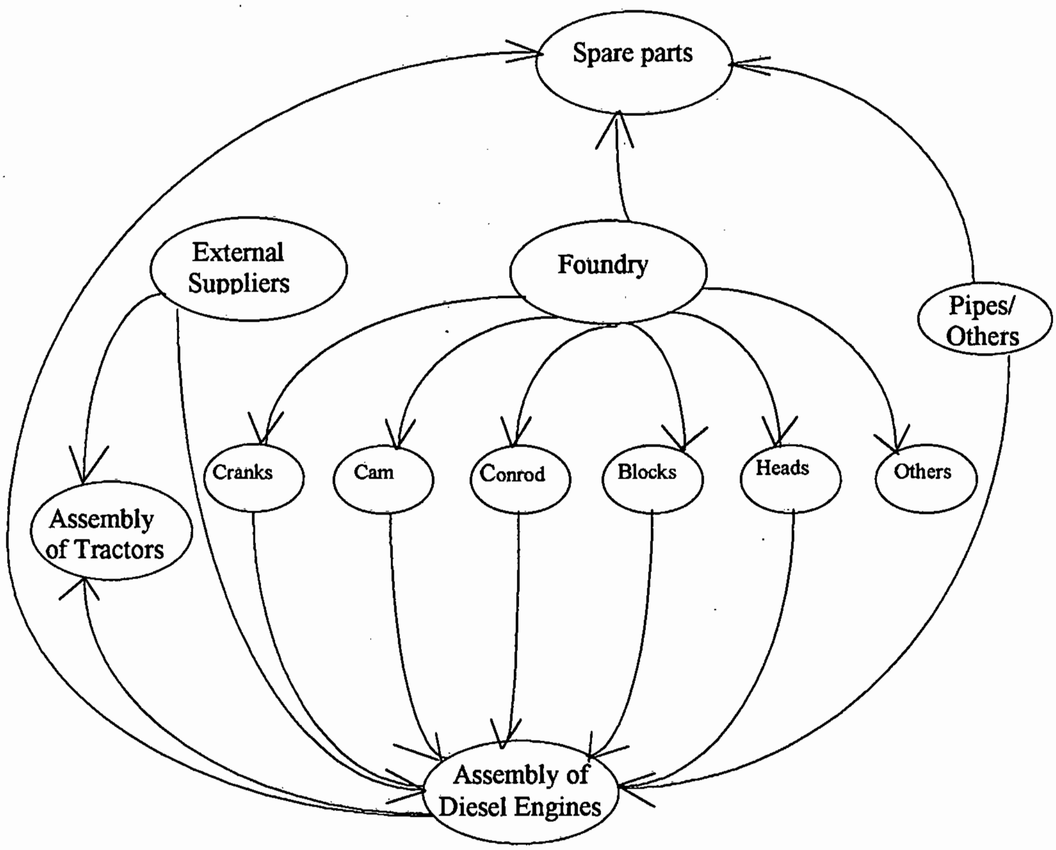


Figure 5-2: INTERACTION OF PARTS OF THE MANUFACTURING BUSINESS UNIT

5.2 DESCRIPTION OF ADE IN TERMS OF THE VIABLE SYSTEM MODEL(VSM)

The Viable Systems Model (VSM) was developed by Stafford Beer a renowned Cybernetician and systems analyst. The VSM is used in this part of the work to diagnose and analyse the situation at ADE. Detail work on cybernetics and VSM has been discussed in section 3.2.4.

5.2.1 RECURSION LEVELS

The concept of recursion, described by Beer (1981), maintains that a recursive organisation is a viable system that is contained in and in turn contains a viable system. Although one recursion level is embedded in another the emerging characteristics are quite different. Organisation structures are only meaningful in a value-added domain and lose their meaning elsewhere. Relationships between work systems of a higher domain with those of a lower domain are not that of management and control. It should lead to the creation of conditions that foster viability.

- **RECURSION LEVEL 1 (R1)**

The system under focus was the crank cell. The S1 functions of this cell are crank line I, crank line II, conrod line, camshaft line. Each S1 function has its own localised management called facilitators who are accountable to the cell manager, who is a manager of an S1 function at recursion level 0(R0).

The S2 function, that is co-ordination between the various production lines and the control functions, are performed by the team leaders in conjunction with the respective facilitators.

Both the S3* and S4 functions as described by Stafford Beers Viable System Model are not apparent. The weakness of the S3* function has a negative impact on the implementation of new programmes such as Statistical Process Control.

The cell manager performs the S5 functions. He plays a major role in implementing any new programme and makes decisions based on available information from the lower systems. The effectiveness of the lower systems (S1 to S4) is a function of the quality and availability of information accessible to the S5.

- **RECURSION LEVEL 0 (R0)**

The system under focus (the crank cell) is in turn part of another viable system (the manufacturing business unit) and along with other cells including Block, Pipes & Miscellaneous, Foundry & Marketing, Manufacturing Engineering, Quality Assurance & Product Services, Tool & Core, Moulding & Melting, Finishing & Customer Services. The manufacturing business unit is at recursion level 0(R0). The localised managers at these levels are the cell managers reporting directly to the General Manager Engineering who in turn reports to the managing director at a higher level.

RECURSION LEVEL 2 (R2)

The production lines described in R1 as S1 functions are viable systems in their own right at recursion level 2 (R2). The S1 functions at this level are the various operations in the production line (workstations). According to the VSM, the operators are suppose to manage their own operation processes.

5.2.2 THE VSM OF THE MANUFACTURING BUSINESS UNIT (R0)

The system one functions ($S1_A$, $S1_B$, $S1_C$, $S1_D$, $S1_E$, $S1_F$ $S1_G$, $S1_H$, and $S1_I$) are the main operations or functions in the manufacturing business unit-. Crank, Block, Pipes & Miscellaneous, Foundry & Marketing, Manufacturing Engineering, Quality Assurance & Product Services, Tool & Core, Moulding & Melting, Finishing & Customer Services.

The system two functions ($S2_A$, $S2_B$, $S2_C$, $S2_D$, $S2_E$, $S2_F$, $S2_G$, $S2_H$, and $S2_I$) are to co-ordination functions for the respective system one functions in the manufacturing business unit.

The local environments for the respective system one functions are: E_A, E_B, E_C, E_D, E_E, E_F, E_G, E_H, E_I.

The local environments are the environments where each respective system one function operates. Most of these environments overlap each other and they are all functions of the bigger environment for the manufacturing business unit.

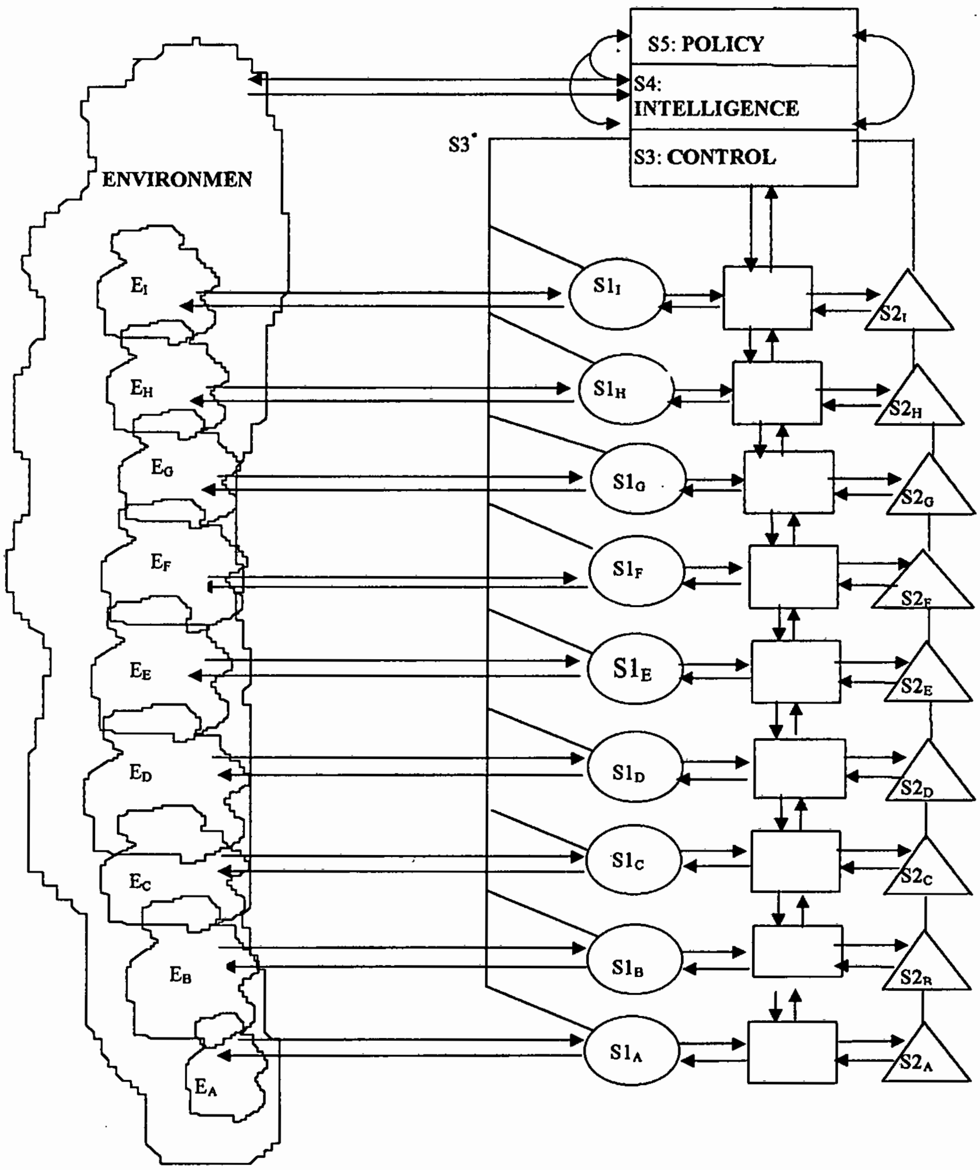


Figure 5-3: THE VIABLE SYSTEM MODEL OF THE MANUFACTURING BUSINESS UNIT

5.2.3 THE VIABLE SYSTEM MODEL OF THE CRANK CELL (R1)

The system one functions ($S1_a$- crank line I, $S1_b$- crank line II, S_{1c}- conrods, $S1_d$- camshaft) are the main operations or functions in the crank cell.

The systems two functions ($S2_a$, $S2_b$, $S2_c$ and S2d) are the co-ordination functions for the respective system one functions in the crank cell.

The local environments for the respective system one functions of the crank cell are: E_a, E_b, E_c, E_d.

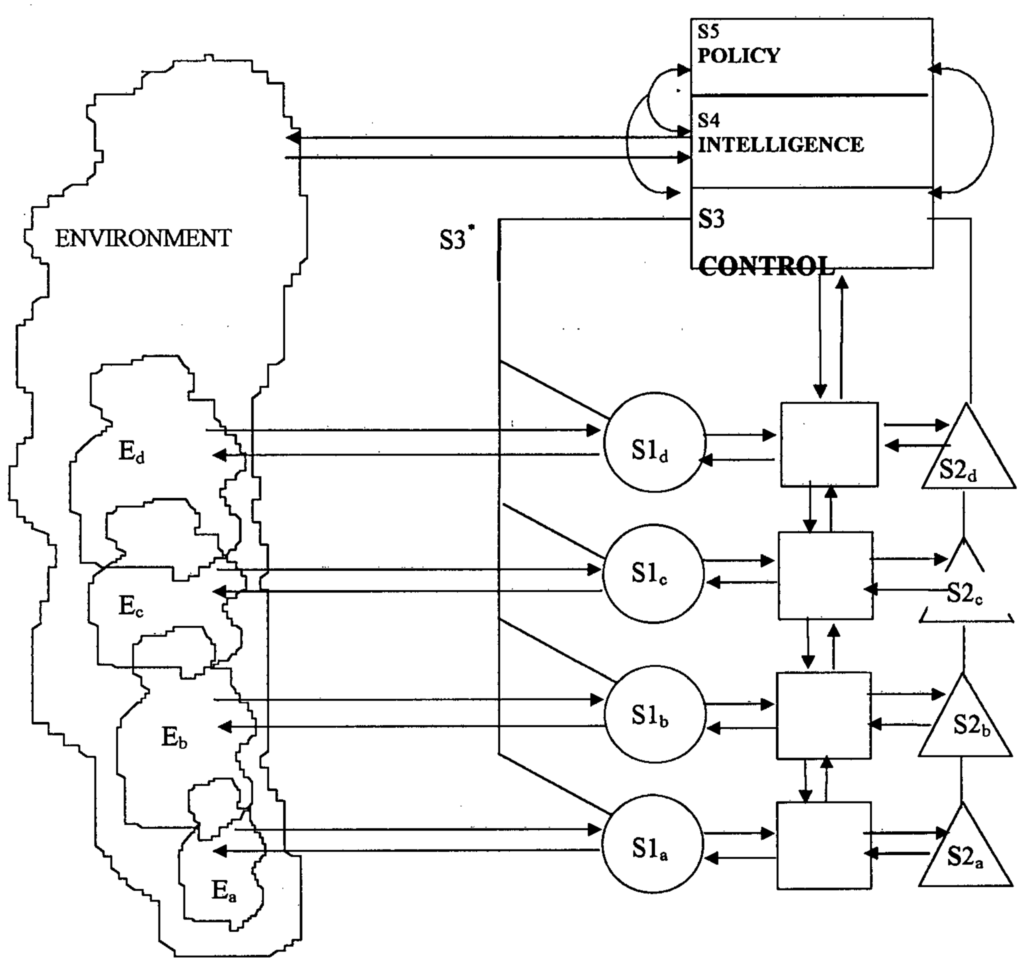


Figure 5-4: THE VIABLE SYSTEM MODEL OF THE CRANK CELL

5.3 THE VIABLE SYSTEM DIAGNOSIS (VSD) OF ADE

The crank cell was analysed using the viable system diagnosis approach.

5.3.1 SYSTEM IDENTIFICATION

The purpose of the crank cell is to manufacture varieties of diesel engine parts such as crankshafts, camshafts and connecting rods. The relevant system for achieving this purpose is the crank cell and the system in focus is the S1 functions of the crank cell.

5.3.2 SYSTEM DIAGNOSIS

Using the VSM to diagnose the organisation it is apparent that all the five functions as described in the viable systems model are present but poorly designed. There are strength and weakness of the entire functional element in description of the organisation as a viable system model. The functions that need much attention are the system 2- co-ordination function, system 3- control function, and system 4- intelligence function.

- *ANALYSIS OF THE IMPLEMENTATION FUNCTION (SYSTEM 1)*

The relevant production lines of the system in focus make up the system 1. Each system one function has its own workers and environment. Each production line is responsible for its operation and workers are responsible for their operations. Production targets are set by middle management in the manufacturing cell not the crank cell.

- *ANALYSIS OF THE CO-ORDINATION FUNCTION (SYSTEM 2)*

The team leaders who are in contact with the machine operators on the shop floor perform the co-ordination function. An effective S2 function dampens oscillations that may arise in the system due to absenteeism, high target set by management and introduction of new methods and techniques in the production process. There is a poorly developed information system, which amplifies the weakness of the co-ordinating function.

- *ANALYSIS OF THE CONTROL FUNCTION (SYSTEM 3)*

Although each worker is responsible for his operation, they are not accountable for what happens in the course of production. Accountability is a major problem in the crank cell; workers are assigned responsibility without accountability. This is not only at the shopfloor but also up the organisational hierarchy. Daily meetings are held by the middle management in the crank cell to address issues and assign people to problems as they arise. Problems are often not resolved on time due to the apparent nature of the S3 function. The viability of SPC in the crank cell needs an effective control function where responsibility and accountability can be maintained to a high level.

This happens to be one of the weakest functions at ADE. Without an effective and efficient System 3 function any improvement programme an organisation may embark on ends up in shambles

- *ANALYSIS OF THE INTELLIGENCE FUNCTION (SYSTEM 4)*

The facilitators perform this function. These facilitators have interactions with the external environment mainly when it comes to ordering of parts for the crank cell. The S4 lacks the intelligence element as described by Stafford Beer's VSM in understanding the external environment in order to remain competitive. With the apparent nature of the S3 function one can guess the sort of information available to the S4 function. It is the responsibility of the S4 function is to feed back to the organisation information on the consequences of embarking on SPC as a quality management tool.

- *ANALYSIS OF THE POLICY FUNCTION (SYSTEM 5)*

The function of S5, implementation of policy and goals, in the crank cell rest on the shoulders of the cell manager in conjunction with the general manager of the engineering business unit. The main responsibility of the S5 function is to see to it that production targets are met. There is a close link and interaction between the S5 and the S2, S3 and the S4, but the question of importance is the quality of information made available to the S5 function. However, the strategic decision and policy making ability of the function is limited by the availability of sound internal and external information. The limited environmental information together with the poor information filtering up through systems 1-4 severely hamper the policy making function's ability to give the proper organisational direction.

CONCLUSION

This chapter revealed that ADE is an organistic organisation with management acting as brain and employees as organs. Comparing the organisational model of ADE to the systems reveals that ADE is an open complex system making up of parts which has a degree of interaction and interdependency but not as described by Ackoff in his description of the social systems model. It was evident that the system functions (S1-S5) were apparently not up to expectation compared to the ideal systems and cybernetic models. The cybernetic model on the other hand indicates that ADE has apparent systems functions whose responsibilities are not distinct.

The next stage of this work is developing a managerial inquiry framework to really find out *why* the problem and *what* can be done to address the problem.

PART THREE

DEVELOPING A FRAMEWORK FOR INQUIRY

After development of the problem statement for this work the next stage is developing a framework for dealing with the problematic situation. When this framework is implemented properly it ought to address cause(s) of the problems at hand.

This framework needs a philosophical foundation, for which Peirce's pragmatism was selected as the appropriate philosophy. The reason for its selection is discussed in the main text of this part of the thesis.

The framework for inquiry is developed using Peirce's work in collaboration with that of Handy, Deming, Kolbs, Minto and many others who have contributed to the scientific method for managerial inquiry.

The reason for developing the framework for inquiry is that problem solvers have different ways of fixing their beliefs and analysing situations. This framework recommends the scientific method of fixing belief and reasoning since process of inquiry is a cyclic learning process.
The philosophy of inquiry is important since it is the search by logical reasoning for understanding the basic truths and principles of the universe.

CHAPTER SIX
FRAMEWORK FOR INQUIRY

The philosophy of inquiry framework described in this chapter is mainly based on the work of Charles Saunders Peirce, a renowned philosopher and a scientist in the twentieth century. The chapter details the fixation of belief and scientific method of reasoning that can be employed by management in inquiry into a problematic situation.

In the process of developing a model of inquiry the researcher identified organisational learning as a catalyst for the inquiry process. The learning organisations and why we need a learning organisation, organisational learning as a means of competitive advantage are explored. The two common types of learning processes 'learning why' and 'learning how' are also discussed, and how organisations can develop these processes as strategic capabilities such that individual members may develop the capacity to diagnose and identify underlying causes in a variety of new situations. The reason for the philosophy is that all managerial inquiry processes need a philosophical basis for it argument.

6.1 PEIRCEAN PRAGMATISM AND TRUTH

Pragmatic approach is treating things from the practical point of view. The central insight of pragmatism is that there is a connection between knowing the meaning of a hypothesis and knowing what experimental consequences to expect if the hypothesis is true. Peirce in his work on pragmatism argued that there is one proper method to analyse an idea. "The method consists in considering what possible practical difference can be involved in the truth of falsity of a proposition involving that idea" (Masik, 1991, pp. 11).

Truth being the aim of inquiry, there is all the more reason to insists that our conception of truth be pragmatically legitimate, for the adoption of such s conception will have s "wholesome effect" on inquiry. The true pragmatist is interested in rational meaning, which consists in experimental phenomena, in "what surely will happen to everybody in living future who shall fulfil certain conditions." Expectation seems to be an important element of Peirce's pragmatism.

6.2 A MODEL OF INQUIRY

The inquiry process is ignited as a result of an unexpected result from a situation. Doubt arises in the inquirer's mind that shakes his or her belief. In order for the inquirer to settle for a permanent belief he has to go through the scientific method of reasoning proposed by Peirce (Reilly, 1970). The purpose of an inquiry process is to remove the irritating stimulus associated with doubt. Inquiry therefore begins with doubt, and ends with belief. Figure 6-2 illustrates the steps and processes of the inquiry process.

6.2.1 BELIEF AND DOUBT

- *Belief*

Belief as described by Peirce is a "demicadence that closes a musical phrase in the symphony of our intellectual life". Belief should not be a stopping point but rather a new starting point for thought (learning cycle). Belief involves the establishment of a rule of action, which though may not be absolutely permanent, is still not completed in a single operation of assent. According to Peirce the questions asked by scientists and the answers proposed by them are theoretical. He goes on to call a question doubt and an answer belief.
Scientific doubt and belief mark the beginning and end of an inquiry process (Reilly, 1970, pp.14).

- *Doubt*

Doubt is an uneasy and dissatisfied state from which we struggle to free ourselves and pass into the state of belief (Reilly, 1970, pp.15). Doubt arises when our belief about reality is challenged and shaken.

6.2.2 FIXATION OF BELIEF

Peirce proposed four methods of fixing belief. These are the methods of tenacity, authority, apriority, and the method of science.

❑ *THE METHOD OF TENACITY*

This is a method whereby one maintains a rigid steadfastness in the belief that he or she holds. The belief that an individual holds may be as a result of or a function of his habit of thought. Tenacity limits the minds of people since they are not prepared to undertake any inquiry that may shake or disturb their belief. This method fixes the individual's belief, but not the community's as each individual holds his or her own belief.

The method of tenacity may hinder improvement programs, as people in managerial positions are often not prepared to face reality and changes in their beliefs of how things work and should be done.

❑ *THE METHOD OF AUTHORITY*

According to Peirce institutions teach people to believe what they would like them to believe, and punish those who refuse to believe. Such institutions treat people as machines and expect them to do what they are told irrespective of their capabilities. These are mechanistic institutions as described by Ackoff. Such a method of fixing beliefs instils fear into the people in the institution and that discourages thinking and forbids organisational learning.

This type of fixing belief hinders progressive organisations, since only few individuals take active part in decisions affecting the organisation. There is no question of *'why"* by people being affected by those decisions. Doubt may arise in peoples' mind but they have to forego their doubts as they have been modelled to accept and belief what the organisation expects them to believe.

❑ *THE METHOD OF APRIORITY*

This is a method whereby an individual adopts views that he or she finds agreeable to his or her reason, independently, perhaps, of observed facts. According to Peirce this method of settling belief makes inquiry a matter of taste or what seems reasonable to the inquirer. This type of belief fixing may have negative impact on organisations since people who adopt this method may indulge in things without considering their consequences critically. Organisations may embark on a improvement programme because management sees it as the only way to survive in a competitive environment, without considering the *hows* and *whys* of the way it works in some other organisations.

- ***THE SCIENTIFIC METHOD***

The method of science is considered the most appropriate and satisfactory of fixation of belief, the reason being its precision in formulating a method that is clear and definite, testable and repeatable. This method as described by Idus Murphree (1959) as "inquiry proper, inquiry in its eulogistic sense." With this method all enquirers have the same worldview. Scientific inquiry begins with a hypothesis, a conjecture that attempts to explain a phenomenon.

Peirce stated that followers of the method of tenacity often ignore questions that might shake their belief; the subjects of authority will look to the authority for the answers to their questions; the apriorists will answer their doubts according to what seems reasonable to them; it is only the scientist who will ask nature for an answer to his question (Reilly, 1970, pp. 24).

6.2.3 THE LADDER OF INFERENCE

The ladder of inference as illustrated in figure 6-1 may be used by an inquirer in focusing attention on the boundaries between data, meaning and belief. It is a step-wise process (learning cycle) where the inquirer takes action based on his or her experience and the necessary data available. The ladder of inference is a common mental pathway of increasing abstraction often leading to misguided beliefs (Senge, 1994). The "reflexive loop" is a phenomenon where an inquirer leaps up the ladder of inference several times reinforcing his belief.

Belief really influence the sort of data one may select the next time he or she may initiate an inquiry process. This can be linked to the interpretation of variation using the Shewhart's (1986) control charts. Points outside the control limits are initially analysed based on our beliefs, and with experience one leaps up the ladder of inference and selects a source of variation considered appropriate for the particular nature of control charts.

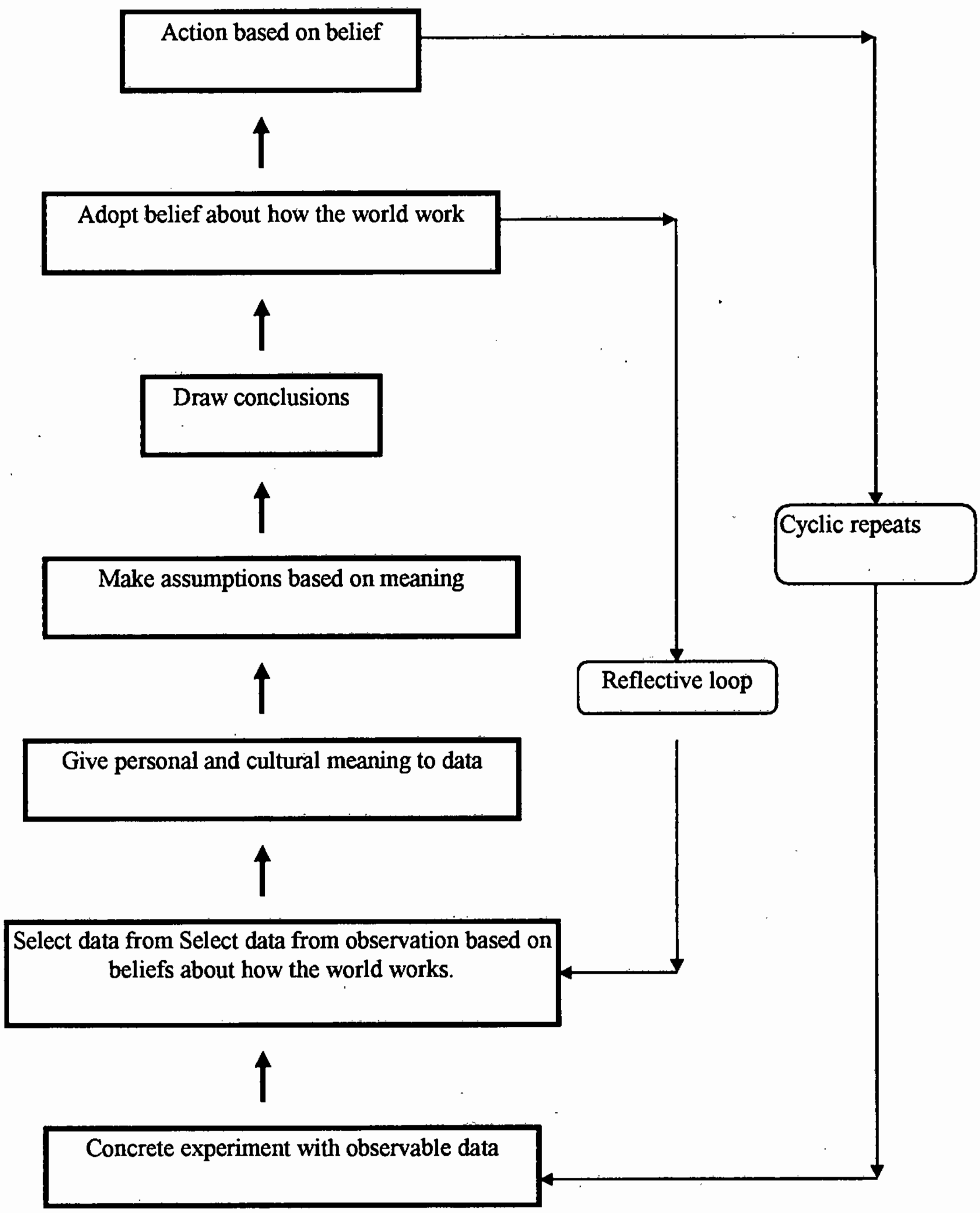


Figure 6-1: THE LADDER OF INFERENCE (Senge, 1994)

The method of fixation of belief plays a significant role in an inquiry process. Figure 6-2 illustrates the various steps an inquirer goes through in other to remove the irritations caused by doubt and to settle for belief.

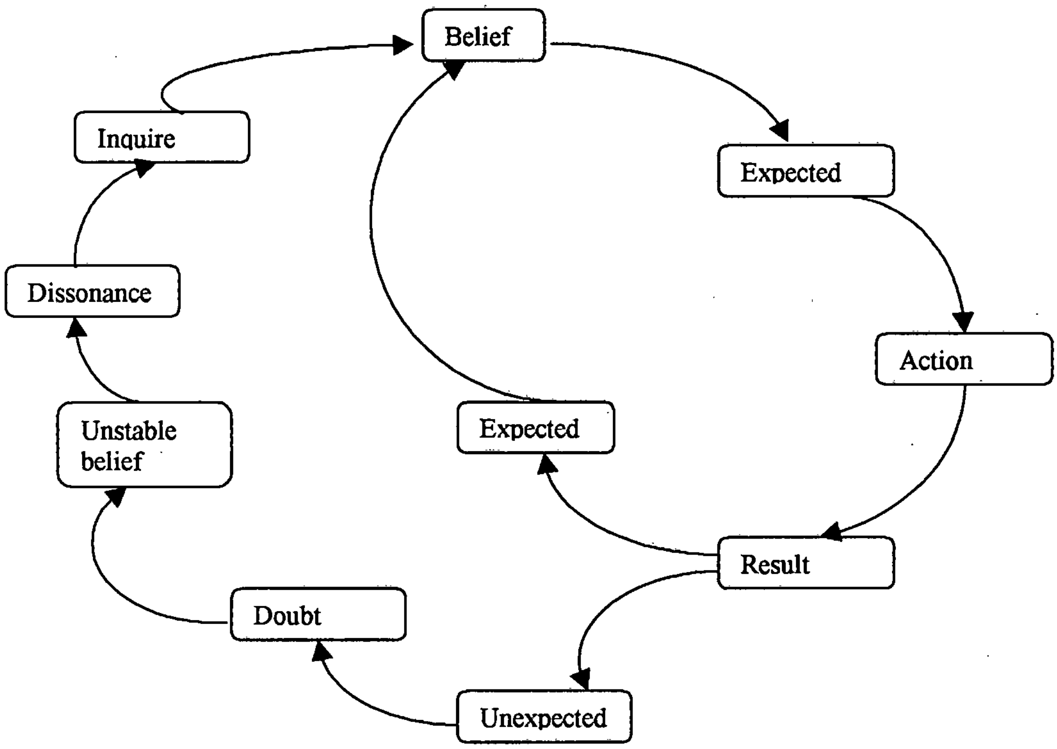


Figure 6-2: MODEL OF INQUIRY

6.3 THE SCIENTIFIC METHOD OF REASONING

The reasoning for an answer to a question can be argued on the basis of Peirce's work on reasoning processes - Abduction, Deduction and Induction. If an inquiry is to move towards truth it must employ all these reasoning processes as shown in figure 6-3.

Reasoning process deals with three distinct entities:

- A Rule (a belief about the way the world is structured)
- A Case (an observed fact that exists in the world)
- A Result (an expected occurrence, given the application of the rule in this case)

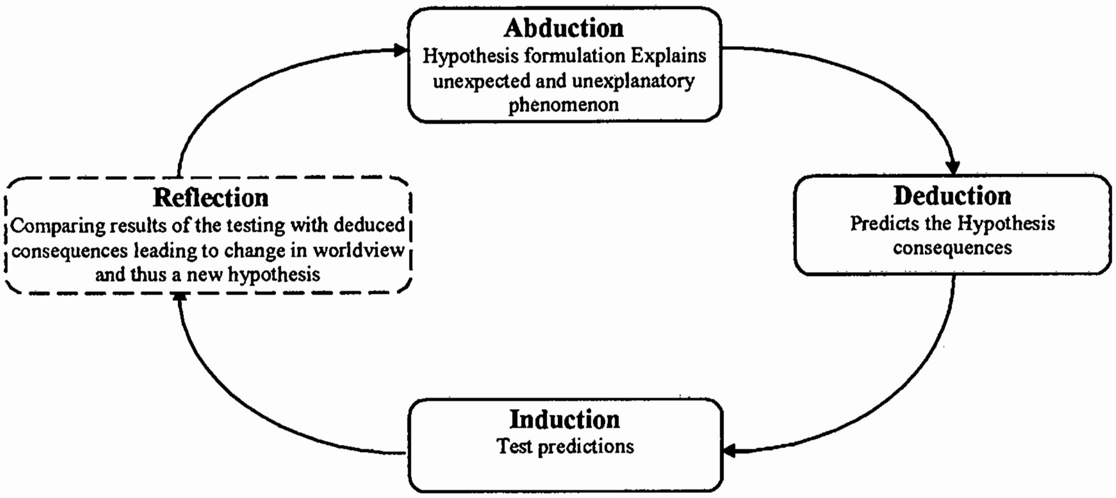


Figure 6-3: THE SCIENTIFIC REASONING PROCESSES

6.3.1 ABDUCTIVE PHASE (Hypothesis formulation)

Abduction is the first reasoning process in the process of inquiry into a situation, and deals with the formulation of an "explanatory hypothesis". Peirce defines abduction as "the mental activity by which a hypothesis is formed". It contains three propositions; the result as a major premise, the rule as the minor premise and conclusion as a case. In the abduction process more than one hypothesis may be formulated to address a particular situation.

Peirce sets out criteria for choosing the most suitable hypothesis:

- needs to be verifiable experimentally;
- needs to be economical, with resources controlled in terms of time, money, and energy;
- it must be easily proved for truth or refuted for its falsity.

Below is an illustration of the abduction phase of the scientific method of reasoning. The situation considered for the illustration of the three reasoning processes is a manufacturing industry having problem problems with the quality of their products and the production processes. Management belief that the use of SPC as a quality management tool may enhance a better quality product and improved production processes.

An analytical abduction of the situation:

Result:	*Problems with quality and process control.*	
Rule:	*One reason for poor quality and process control*	**If X**
	due to *utilisation of SPC and its results*	**Then Y**
	in making processes management decisions.	
Case:	*check if full utilisation and implementation*	**Possibly**
	of SPC will have effect on the quality and process control	**X**

In the abduction phase we consider also why implementation and utilisation of SPC is a problem in our case study.

Abduction furnishes the inquirer with the problematic theory which induction verifies. The next stage in the reasoning process is deduction (Really, 1970, pp.38).

6.3.2 DEDUCTIVE PHASE (Hypothesis Consequences)

Deduction is unfolding of experimental consequences from the explanatory hypothesis. This is the initial testing phase of the "explanatory hypothesis". The deductive stage must deduce observable predictions from the hypothesis selected. The hypothesis must be put as a question prior to the observation stage to test for the genuineness of the predictions and the predictions must be observable. Experiments lead to experience and through experience the truth of the result can be established.

Deduction on the other hand is inference of the results from a rule .In deduction rule is for a major premise, a case for a minor, and result for a conclusion.
Deduction presents a line of reasoning that leads to a 'therefore' conclusion.
In deductive argument one needs to:

- Make a statement about a situation that exists in the world. An example is that most Japanese companies are doing extremely well their manufacturing and operations management. An attribute to this success is the tremendous effort by all employees to use statistical quality tools in managing their operations.
- Make another statement about a related situation that exists in the world at the same time. The second statement relates to the first if it comments on either its

subject or its predicate. Example of such a statement is, in South Africa, SPC and its tools are giving positive results to some industries in the Western Cape where as others are still striving to reap the fruits of SPC and its tools.

- State the implication of these two situations existing in the world at the same time.

Below is an illustration of the deductive phase of the scientific reasoning process.

The deductive phase of the situation:

Rule:	*If SPC if fully implemented and utilised, high quality of products will be produced and processes will be under control*	**If X then Y**
Case:	*We have implemented and utilising SPC to its limits.*	**X**
Result:	*:Therefore, high quality products will be produced and processes. will be under control*	**Necessarily Y**

The deductive process in a scientific inquiry must result in genuine predictions of the "if-would" variety.

6.3.3 INDUCTIVE PHASE (Hypothesis Testing)

Induction is the process by which the inquirer scrutinises nature to see whether the predicted observable consequences of the hypothesis actually occur (Reilly, 1970, pp.62). This involves the actual testing of predictions that must converge on truth. The inquirer then judges the hypothesis according to its success in predicting; from this evaluation he/she proceeds to adopt, adjust, modify, or reject the hypothesis.

Induction defines a group of facts to be the same kind of thing, and then make a statement about the sameness. In deductive reasoning the problem solver needs to define the ideas in the grouping and identify the misfit among them (Minto, 1982).

There are two requirements to be met by the scientific induction:

i. The inquirer must determine what he is testing for, before he begins to test. In this work the inquirer is testing/finding out if the proper usage of SPC enhances quality and productivity by stabilising manufacturing processes.

ii. Besides predesignating the character to be tested, the inquirer must honestly pledge that the instances examined constitute a fair sample of the class of instances under question. The instances considered are ADE an automobile industry where SPC was adopted years back and some clothing industries in Western Cape who were involved in SPC pilot programme in 1996.

In the inductive phase of our reasoning the hypothesis needs to be tested in a different situation or environment for its validity.

Below is an illustration of the inductive phase of the scientific method of reasoning.

The inductive phase of the situation:

Case:	*SPC has been implemented and it is fully utilised by everyone involved in processes in need of SPC.*	**X**
Result:	*High quality products are produced and production processes are under control.*	**Y**
Rule:	*The reason for the high quality products and process control is probably the implementation and utilisation of SPC and using its results in making decisions.*	**If X then Probably Y**

6.3.4 REFLECTIVE PHASE

The reflective phase, although is not strictly part of the scientific inquiry process is considered important in the cycle since it is only by reflection can the inquirer concluded the validity of the inquiry process. The hypothesis formulated in the abductive phase goes through to the deductive phase where the consequence of the predictions are verified and then to the inductive phase where it is tested. If the results obtained after all these stages are compared to the expected and reviewed, and the inquirer's question is not settled or is uncertain from the results, the cycle is revisited for improvement.

In induction, the enquirer scrutinises nature to see whether the predicted observable consequences of the hypothesis actually occur. From the outcome of the prediction the enquirer may adopt, adjust, modify, or reject the hypothesis.

The inquirer must not look for results that will confirm the predictions or theory, otherwise they will deviate the principles of the scientific method. The three phases of reasoning Abduction Deduction and Induction are also considered as the theory, prediction, and the experience phases respectively.

In exploring the scientific reasoning processes, organisational learning and a learning organisation are the prescription.

6.4 LEARNING ORGANISATIONS

Learning organisation gives people hope that things can improve by providing a playground for creative ideas. It also provides a safe place to take risks with new ideas and behaviours and the challenge needed to stretch beyond perceived limits. The main driver towards organisational learning is change. Environmental change consistently challenges traditional institutional practices and beliefs, the most compelling of which is '*Systems Thinking*', that is the ability to see the world as a complex system made up of interdependent parts. These environmental changes normally shake the belief of managers, which calls for immediate observation. This mostly results in doubts, and as doubts arise in the mind of managers the need for inquiry begins, as Peirce has stated. The process of removing doubt in the mind of an inquirer is a learning process that promotes organisational learning.

6.4.1 BARRIERS TO LEARNING ORGANISATION

The two prominent barriers to leaning organisation are:

- Defensive routines

The use of defensive reasoning results not only in skilled unawareness of the gaps between espoused theories and theories-in-use; it also leads to skilled incompetence. Individuals skilfully follow the dictates of their defensive reasoning which leads them to become highly limited learners and create organisational learning systems that are also highly limited in learning. Organisational defensive routines are said to be the most powerful system that limits learning at all levels of the organisation. Organisational defensive routines are considered to be anti-learning.

♦ Dynamic complexity of systems and inadequate and ambiguous feedback.

6.5 ORGANISATIONAL LEARNING

Organisational learning occurs when any of the organisation's members acquire knowledge that the unit recognises as potentially useful to the organisation. This is an attempt to avoid '*narrow conception*' that decreases the chance of encountering useful findings or ideas. This involves the detection and correction of errors.
Theory- in-use is a theory of action constructed from observation and actual behaviour. In order to discover the organisation's theory-in-use, one must examine its practice, that is the continuing performance of its task system as exhibited in the rule-governed behaviour of its members. The process of detecting and correcting errors is a process that is governed by the framework for fixing beliefs. Errors can only be detected when there is doubt emerging after observation.

Organisations on their own do not perform actions that produce learning. Individuals act as agents of organisations in producing the behaviour that lead to learning. Individual learning may enhance organisational learning, but is not necessarily a sufficient condition for organisational learning.

Most management theories are about taking action to achieve goals, objectives, or intended consequences. Improvement programs such as Total Quality Management (TQM), Quality Function Deployment (QFD), Business Process Reengineering (BPR) and Statistical Process Control (SPC) focus on goals, especially those producing competitive advantage. A major claim is that organisational learning is the key to achieving these goals.

As the business climate changes, and becomes more turbulent every day, organisations find it difficult to remain competitive. Organisations facing uncertain changes need to be able to learn and, since organisational learning enhances managerial actions to improve effectiveness, it is recommended to achieve this goal.

Most managers are aware of the difficulty of taking action based on this as prescription because managers themselves are not committed to organisational learning.

Argyris (1978) proposes that developing a comprehensive theory of management require integration between technical theories in management and the behavioural theories that delineate barriers to their implementation. The development of a comprehensive and less fragmented management theory requires a cross-disciplinary dialogue to become familiar with other perspectives as described in section 4.2.1.2.

Argyris and Schon formulated questions to verify the occurrence of organisational learning (Schon and Argyris, 1978).

i. Did individuals detect an outcome that matched and mismatched the expectations derived from their images and maps of organisational theory-in-use?
ii. Did they carry out an inquiry that yielded discoveries, inventions, and evaluations pertaining to organisational strategies and assumptions?
iii. Did these results become embodied in the images and maps employed for the purposes such as control, decision, and instruction?
iv. Did members subsequently act from these images and maps so as to carry out new organisational practices?
v. Were these changes in images, maps, and organisational practices regularised so that they were unaffected by some individual's departure?
vi. Do new members learn these new features of organisational theory of action as part of their socialisation to the organisation?

Systems dynamists have proposed that for the organisational learning to occur, conditions such as tools and training are required to facilitate the diagnosis of the dynamics of the organisations in which actors find themselves (Senge, 1992).

6.5.1 TYPES OF ORGANISATIONAL LEARNING

The type of organisational learning that may be employed by organisations depends on what needs to be achieved and the resources available. Argyris and Schon proposed three types of organisational learning; these include:

- Single-loop learning;
- Double-loop learning;
- Deutero learning.

SINGLE-LOOP LEARNING

Single-loop learning is said to occur when mismatch or error is corrected by altering behaviour or changing actions. In single-loop learning members of the organisation respond to the changes in the internal and external environment of the organisation by detecting errors which they can correct so as to maintain the central features of organisational theory-in-use.

Single-loop learning has a single feedback loop, which connects detected outcome of action to the organisational strategies and assumptions, which are modified so as to keep organisational performance within the range set up by the organisational norms. Single-loop learning is more appropriate for routine, repetitive issues.

DOUBLE-LOOP LEARNING

Double- loop learning occurs when the underlying values are changed and then new actions follow. This process involves management changing their beliefs about how the world works and its built on new and innovative insights into ways of dealing with complex problematic situations. Double-loop learning comprises types of organisational inquiry which resolve incompatible organisational norms by setting new priorities and weighting of norms, or by restructuring the norms themselves together with associated strategies and assumptions (Argyris and Schon, 1978).

It is possible to speak of organisational learning as approximating to double-loop learning since inquiry goes as well as it begins. Organisations may learn more or less, yet their inquiries may still qualify as learning of the single-or double-loop kind.

Double-loop learning is more relevant for complex, non-programmable issues - such as introduction of Total Quality Management (TQM), Quality Function Deployment (QFD), and Statistical Process Control (SPC) programmes in an organisation. Double-loop action controls the long-range effectiveness unlike single-loop action where the main focus is solving problems as they arise for short-term purposes.

The difference between double- and single-loop learning are illustrated in figure 6-4.

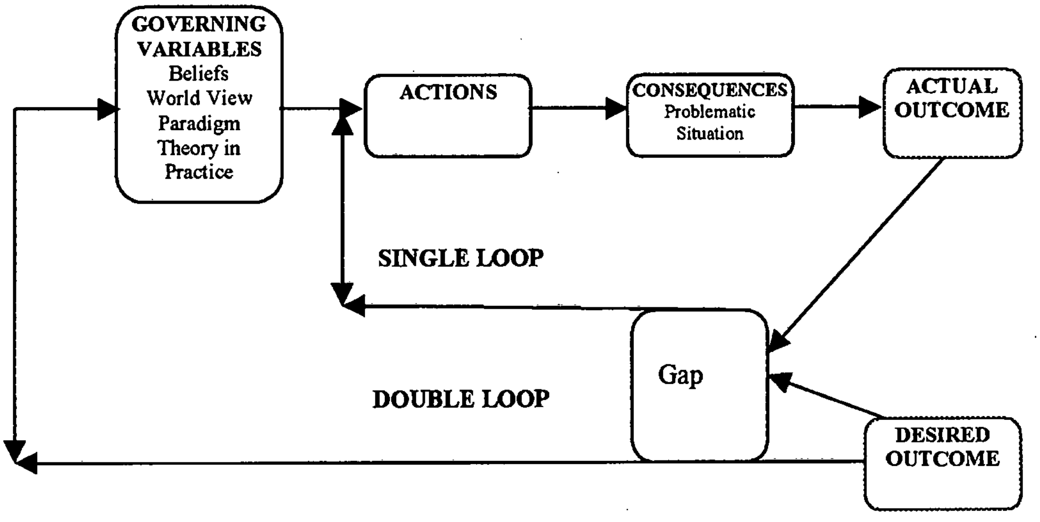


Figure 6-4: SINGLE AND DOUBLE LOOP LEARNING (Argyris, 1992)

- *DEUTERO LEARNING*

This is second-order learning where the organisation needs to learn how to carry out single- and double-loop learning. Organisations need to learn how to restructure themselves, at regular intervals, so as to be abreast of new technologies and developments. This may include restructuring of the organisational structure, Business Process Reengineering.

Many organisations do not encourage organisational learning since they see individual learning as enough for their existence. In situations where it is encouraged they indulge in single-loop learning. Single-loop learning is like fire fighting in management. One of the reasons why organisational learning is not encouraged is that people are not then subject to change and the fear of shaken belief.

6.5.2 LEARNING PROCESSES

There are two kinds of learning processes that enhance organisational learning: Learning how and Learning why.

- *LEARNING HOW*

Learning how is engaging of organisational members in processes designed to transfer and/or improve existing skills and routines. Learning how reduces or if possible eradicates the practice of *'Just tell me how to do it, not why it works'*, which basically hampers almost all improvement programs as well as implementation of new programs in organisations.

In developing learning how as a strategic capability, organisations become expert in implementing new processes such as Statistical Process Control, with a high degree of consistency. Learning how involves the application of a set of procedures characterised by imitation and error corrections.

- *LEARNING WHY*

Learning why is inquiring by organisational members into causality using diagnostic skills. Diagnostics tools such as soft system methodology (SSM), viable system model (VSM), work systems (WS) and many more are tools that can be used by problem owners to inquire and diagnose a situation. The objective in learning why is to discern underlying logic or causal factors. Learning why is the application of a set of routines characterised by asking questions (why the system works in a particular manner) about contexts and systems.

Organisations develop both capabilities of learning how and learning why as a source of competitive advantage.

6.6 LEARNING CYCLES

The dynamic nature of the business environment is forcing organisations to embark on continuous learning in order to survive and stay competitive. Learning requires more than action. We need to question, to understand and reflect on our action, thoughts, beliefs, and values. This can be achieved by adopting the learning cycle in our learning process, rather than the orthodox learning process where the concept is often one-dimensional. That is, when a problem arises, try to solve it if it is well understood; if it can not be solved we learn in order to solve it; after solving the problem we relax until another or more problems surface. This is more of a fire-fighting type of management. Managerial learning is only meaningful if there is a resultant change in behaviour as a result of change in theory-in-use.

The learning cycle is a continuous cycle; as problems arise and are solved new problems emerge and this is all the more reason why action learning, which focuses on learning and working simultaneously, is considered importance in effective management

Handy (1981), Beatson, Mumford, Pedler (1983), Kolb, and others argue that learning is a constant cyclic process.

6.6.1 ACTION LEARNING CYCLE

In the action learning cycle the action learning group make observation of the system under focus and based on their knowledge and experience, they reflect on their observation. After the reflection stage a hypothesis is formulated to deal with the problem at hand, this hypothesis is reflected on to test its validity and if it passes the test then action is taken to address the issue or problem at stake.

In the case of this thesis the crank cell where SPC is employed was under observation to find out why the system behaves is behaving the way it is or is yielding such a result. After observing the system the action learning group reflect on their observation based on knowledge and experience. A hypothesis is the formulated to deal with the problem. Action is then taken after the hypothesis is reflected on by the use of case studies of companies employing SPC as a quality management tool. The result of the action taken is observed for its validity. If the expected result is achieved, then the action leaning cycle is complete. If not then the process is retraced for a better result.

The action learning cycle is shown in figure 6-5.

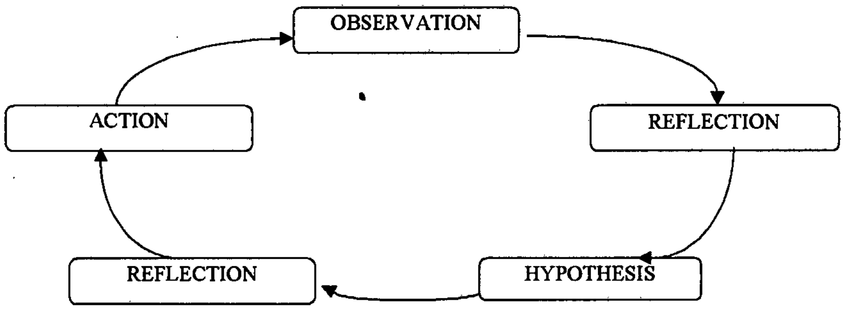


Figure 6-5: THE ACTION LEARNING CYCLE

6.6.2 THE WHEEL OF LEARNING

According to Charles Handy, times are changing and we need to change with them. We need to learn to change and there can be no learning without change. Handy's Wheel of Learning has four stages: Question - Theory - Test – Reflection, as shown in figure 6-6.

The learning wheel proposed by Handy starts with a question, which can be a problem to be solved in an organisation, a dilemma to be resolved or doubt to be removed the inquirer's mind. Handy further states that unless the question is personal, that is the person or people involved in the wheel of learning take the responsibility as owners of the problem, it would become difficult to go through all the difficulties involved in the various stages of the learning cycle.

The second stage of the learning cycle is the theory stage. This is a stage where all the possible ideas are tabled and analysed to find the best fit for the problem at hand. Handy calls this stage the stage-of speculation, -of freethinking, -of re-framing, and -of looking for possible clues.

The theory stage is followed by the testing stage. This is the most critical stage in the wheel of learning. If the situation from which the question arises is not well understood then testing becomes just a formality since there is nothing to reflect on. Understanding the situation reveals the validity of the test, whether the results of the test are positive or negative.

The reflection stage is the final stage for one complete cycle but not the whole learning cycle. If results from the testing stage are not the expected or predicted the learning cycle needs to be revisited to achieve the desired or expected result. This stage focuses on the understanding and the outcome of the tests. The reflection stage answers the question *why*, that makes the stage very important, since understanding *why* is the reason for any learning process.

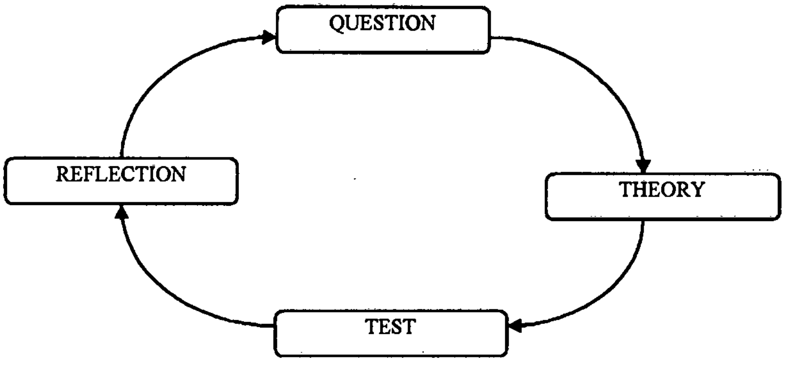


Figure 6-6: HANDY'S WHEEL OF LEARNING

6.6.3 DEMING LEARNING CYCLE

For an effective management of an organisation, each unit within an organisation can practice Plan-Do-Study-Adjust cycle continuously to stay competitive. Adopting Deming's cycle can stabilise processes and identify opportunities for improvement programmes.

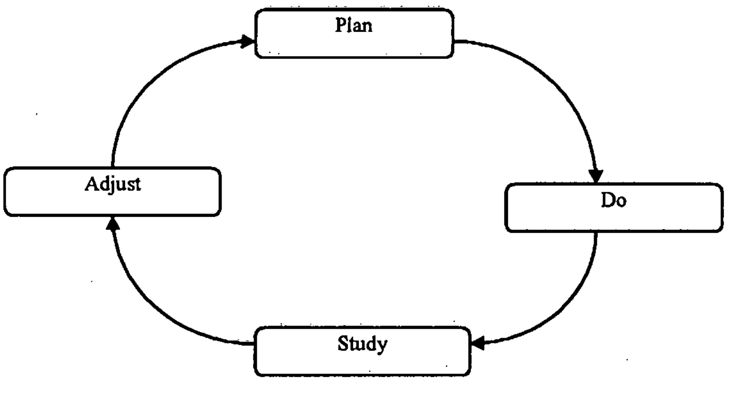


Figure 6-7: DEMING'S LEARNING CYCLE

- **Plan**

In the first stage of the learning cycle, the gap between the current situation and the desired future situation is identified. Steps to improve the situation are set out in a logical manner.

- **Do**

This is the second stage of the process, it is the implementation of the plan for the change.

- **Study**

This stage involves monitoring and inspecting the outcome of the Do stage. There are two critical questions to answer at this point (Melnyzk, 1995, pp.157):

- Is the anticipated relationship between the manipulated variable and performance occurring?
- Is the implementation creating any downstream problems or improvement?

This is the stage where the inquirer compares the actual result with the anticipated result and finds out if there is any gap between them.

- **Adjust**

This is the final stage of the cycle. If the gap between the expected and the actual results is accepted by the enquirer then a cycle is completed, if not accepted then the cycle is repeated or retraced for continuous improvement.

6.6.4 KOLB'S CIRCULAR LEARNING PATTERN

The four stages in the Kolbs learning cycle (see figure 6-8) are: Concrete experience - Observations and Reflections - Formation of Abstract Concepts - Testing Implications of Concepts in New Situations.

According to Mumford learning begins with the here and now experience. With a changing situation new idea(s) erupts, with new experience creating doubt that needs to be removed from the inquirer's mind. This leads to acquiring information about the current situation so as to gain a better understanding of the situation.

The second stage is the observations and reflections stage. This is the stage where data are analysed and theories formulated to deal with the situation.

The third stage is the formulation of abstract concepts and models based on theories. This is a stage were inferences are made from the formulated theories and their relationship to the real world situation.

The final stage deals with testing implications of the concepts in the new situation. This is the stage after which the inquirer may initiate another cycle if the results for this test deviate from experience or what was expected. Even if the result is desirable it may still be used as a starting point for the next learning cycle.

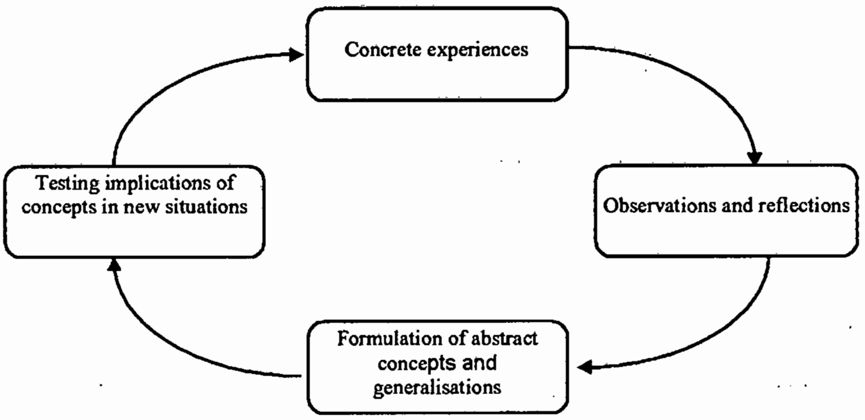


Figure 6-8: KOLB'S LEARNING CYCLE

Critical studying of the learning cycles discussed reveals that the cycles have the same fundamental purpose by trying to remove doubt that arises as a result of irritation.

CONCLUSION

With an appropriate management inquiry framework, managing a problematic situation starts from the method of fixation of belief, which must not be shaken easily for doubt to arise. As stated in section 6.2.2 according to Peirce's work the scientific method of fixing belief is the most appropriate, based on the fact that it passes the test of the three reason processes- abduction, deduction and induction. In going through the three reasoning processes the inquirers belief is challenged and shaken which results in doubt on his or her mind. In order to remove this doubt the inquiry need to reconsider organisational learning and learning processes. Organisational learning and behaviour contribute to the effectiveness of the inquiry process since the process of inquiry is a learning process that is influenced by the culture of the organisation and its people.

Organisational learning as discussed in this chapter gives organisations striving to be world class players in their field of operations a competitive edge over others. In introducing improvement programmes such as statistical process control and others, organisations need to review the type of organisational learning and the learning processes they employ. It is only through learning that organisations can appreciate the positive impact of improvement programmes on their operations. Learning organisations empower people to effect change and to change attitudinal and institutional barriers to learning. Manufacturing industries need learning organisations because the dilemmas in the production system today are not simple; they cannot be explained in simple thoughts and words.

The learning organisation creates the environment for people to look into assumptions and beyond perceptions of their work, to learn more and gain understanding in order to make informed decisions. Until the time when managers can possibly answer the question '*why are things as they are?*' the learning organisation is not yet created.

Organisational learning is important because no managerial theory, no matter how comprehensive it might be, is likely to cover the complexity of the context in which the implementation of any program is occurring (SPC in this case for continuous improvement). Since there will always be gaps and there will always be gap filling, organisational learning is critical in detecting and filling the gaps.

For effective management in the changing business environment organisations need to adopt the culture of continuous learning to seek the secret of competitive advantage. Organisational culture and behaviour influences organisational learning which in effect influences the introduction of statistical process control, the next chapter looks at organisational culture and behaviour and its influence on the introduction of SPC and other improvement programmes.

CHAPTER SEVEN
UNDERSTANDING ORGANISATIONAL CULTURE AND BEHAVIOUR

This chapter discusses organisational culture and behaviour and its influence on improvement programs. The implementation and success of any programme that an organisation may embark on are highly influenced by the organisational culture and its behaviour. The successful implementation of improvement programmes such as Total Quality Management (TQM), Business Process Reengineering (BPR), Quality Function Deployment (QFD), Statistical Quality Control (SQC) and many others depends on the change of attitude of all employees from the top management to the shopfloor. Organisations need to take into consideration the cultural influence of the individuals and the organisation as a whole in implementing any improvement programme.

7.1 CULTURAL CHANGE AND CHALLENGE

The culture of an organisation may be defined as the influence on its employees of its cumulative development since its formation. Organisations develop ways in which knowledge is obtained, analysed and interpreted and ways in which issues at hand are discussed and decisions taken.

Organisational culture may have influence on any programme an organisation may embark on if not considered rigorously in the strategic planning for its implementation. Furthermore, organisational culture plays a significant role in organisational learning. If the culture of '*this is the way things are done here*' is not changed there will always be a gap between actual and expected results due to the fear of threats and of shaken belief.

Organisational culture is a kind of learning. It is a 'learned product of group of experience' and its strength is a function of the convictions of an organisation's founders, the stability of the group or organisation, and the intensity and nature of past learning experiences. Organisational culture often creates a limit for managerial authority and ownership. Since culture is an obstacle or influencing variable, strategic planning and implementation of any program must take into consideration those aspects of cultural knowledge that absolutely cannot be neglected. Any organisation need a vision framework that includes its guiding philosophy, core values and beliefs and a purpose that should be combined into a mission, which provides a vivid description of what they will be like when it is achieved.

7.1.1 CULTURAL KNOWLEDGE IN ORGANISATION

Sonja (1994) describes eight content areas relevant for understanding the cultural knowledge in an organisation. They refer to commonly held beliefs about an organisation's purpose, its structure, strategy, organisational members, task accomplishment, adaptation and change, and relations among people as well as their learning mechanisms.

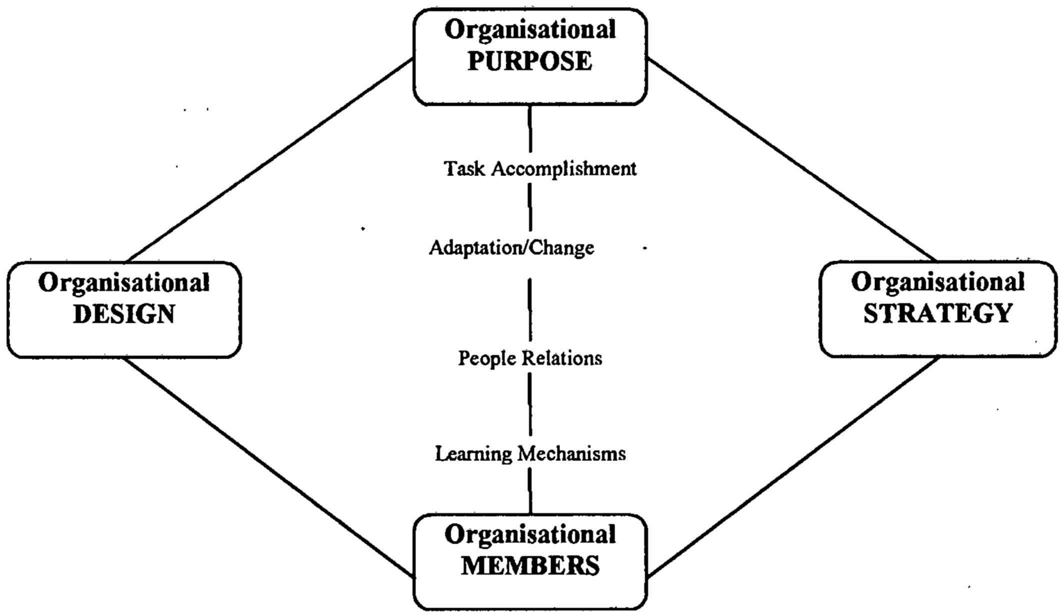


Figure 7-1: CONTENT AREAS OF CULTURAL KNOWLEDGE (Sonja, 1990)

The four pillars of cultural change, organisational purpose, organisational members, organisational strategy, and organisational design, present a frame for the four processes (see figure 7-1). These pillars determine the range of possibilities from the way tasks are accomplished, how people relate to each other, how they accomplish adaptation and change, and the way learning takes place within a certain cultural environment.

- *ORGANISATIONAL PURPOSE*

This refers to the beliefs about the mission or the major intended goal seen for the organisation. The purpose of the organisation must be clear and stated explicitly so that all employees, no matter what their level in the organisational hierarchy, know the reason for the existence of the organisation. This is a problem in many organisations where only management knows the purpose of the organisation. Employees in most organisations only see the purpose as using their manpower to satisfy management's need and in return be rewarded for their services. People in this case are treated as machine parts and the organisation as a mechanistic system, these people feel they are not part of the organisation as a social system.

- *ORGANISATIONAL MEMBERS*

This refers to an area of belief about human beings and their nature, needs, skills and capabilities. People are not subject to change but changes in beliefs about organisational members and purposes of specific organisations may, nevertheless, occur. However, if they occur they are most likely to be based on dramatic events and will have a revolutionary rather than evolutionary nature (Sonja, 1990, pp. 14).

A typical example of such a change is the current situation in South African industries where people are subject to changes based on organisational policies such as '*affirmative action*'. Organisations find it difficult to educate people to change their beliefs about their members. Some part of management see employees as organs and themselves as the brain of the system. This is the main contributor to the '*we-they*' situation that hampers progress of any improvement programme.

- *ORGANISATIONAL DESIGN:*

This refers to formal aspects of organisational design such as job design, lines of responsibility and means of co-ordination and control. The efficiency and effectiveness of an organisation depends on the organisational design / structure as described by Stafford Beer's (1981) viable system model (VSM) in section 3.2.4.3 of this thesis. From the VSM point of view the orthodox organisational structure is more of a problem to effective management since it has not put in place systems functions to co-ordinate activities that can cause oscillations in the whole system.

❑ *ORGANISATIONAL STRATEGY*

Organisational strategy refers to generalised plan for action that portrays and describes the best ways to achieve an organisation's major purpose. Organisational strategy is a broad formula for the way a business is going to compete, what its goals should be, and what policies would be needed to carry out those goals (Sonja, 1990, pp.14). Organisational strategy is set with the hope of streamlining activities in the organisation. In achieving these goals, management in one way or the other think for the organisation as a whole in formulating and setting strategy and policy, which in the end become impossible to achieve due to break in communication from bottom up in the organisational hierarchy.

❑ *TASKS ACCOMPLISHMENT*

The process of task accomplishment depicts organisational members' theories of action in achieving certain outcomes. In the case of decision making these beliefs specify who has to be involved, what kind of information is gathered and where it is obtained, and what kind of people make final decisions. This may hinder the success of improvement programmes, since most members' theories of action may not be able to address current issues erupting in the dynamic environment. Mental models of members need to be reviewed and this can be achieved through organisational learning.

❑ *PEOPLE RELATIONS*

Beliefs about processes regarding people relations refer to organisational members' theories of action about how to relate to and interact with other people (stakeholders) who are relevant to the organisation. This is an important element for creating an environment for effective communication that is a necessity for effective organisation. Poor communication often creates a gap between actual and expected outputs. This is one of the most important elements for the success of any organisation, based on the fact that people are different in all aspects of life.

- *PROCESS ADAPTATION AND CHANGE*

The structural process adaptation and change refer to organisational members' theories of action and their knowledge on how to accomplish change. This set of beliefs describes how to adapt to changing conditions as situations emerge from the organisation's relevant environment. These beliefs specify what has to be done if new technology or a programme such as Statistical Process Control emerges within the industry. Organisational members need to understand the reason for a change and its consequences as well as the benefits from a change. Since people are not easily subject to change it is quite important to stress the issue of the reason for a change in an organisational environment.

In Stafford Beers's Viable System Model (VSM), the System 4 function is responsible for process adaptation and change. The System 4, as described in section 3.2.4.3 is the intelligence function that provides the organisation with the relevant information from the environment.

- *LEARNING MECHANISM*

Learning mechanisms are concerned with ways of acquiring new knowledge and preserving existing knowledge. They represent theories of action about how to promote individual and organisational learning. Organisational learning can be promoted through action learning and empowerment, which in effect can make people not only responsible but also accountable for their work.

7.1.2 EMPOWERMENT AND ITS EFFECT ON ORGANISATIONAL CHANGE

Empowerment is not simply telling people they are empowered. Organisations need to create an environment where people feel empowered and free from any threats. An empowered organisation is one that uses all the talents and skills of its people. Empowering people make them feel part of the team, responsible not only for their own results but also for the results of the team. Empowered employees take pride in whatever they do, are supported in developing their own full potential and are able to

use their initiative to make a difference. Empowerment is one of the secrets of the Japanese success in the world market.
The organisation and its members need to gain insight into the relationship between cultural knowledge, strategy and organisational process. Strategy influences organisational culture and, conversely, the organisational culture influence strategy.

The greater the degree to which improvement programs challenge the existing organisational culture, the greater will be management resistance. Most managers claim they are committed to change, but they remain sceptical of its benefit.
Two important barriers to improvement programs such as Statistical Process Control are:

i. Achieving culture change.
ii. Changing management behaviour.

The question at this point is "Should the culture of a company and its management behaviour have such an influence on its ability to adapt successfully to an improvement programme.

CONCLUSION

Organisational culture as elaborated in this chapter plays an important role in activities going on in an organisation. Management may use the eight content areas discussed in this work as guidance in understanding the culture of their organisation before thinking of embarking on any programme. Organisational culture may address issues such as the *'we-they'*, thrust, empowerment and commitment of employees. Until the time that management will change their attitude and belief that if something needs to be done, assume you have the authority to act and their responsibility as managers is to support others decisions but not to make them for you them, organisations will still stay mechanistically modelled. The next stage is the implementation phase where management intervention is necessary for the implementation of the framework in addressing the problematic situation.

PART FOUR

THE IMPLEMENTATION PHASE

Once a framework for dealing with the problematic situation has been developed the next stage (phase) of the project is to implement the use of the framework to dissolve or resolve the problematic situation for which the framework was designed.

In the implementation phase the framework should be used as a managerial tool for the current situation and if suitable recommended for future use. Since the whole research approach is a cyclic learning process, provision should be made for adjustment whenever conditions are changed (double-loop learning).

Although in the present research time did not allow the framework to be fully implemented and tested for recommendation in a real world situation, the implementation plan was outlined.

The reasons for the implementation phase it to discover the capability of the inquiry framework to address the problematic situation. If it is found that the framework is inadequate to address the problem it can be revised or retraced for improvement since the research is a learning cycle.

CHAPTER EIGHT
MANAGEMENT INTERVENTION FOR IMPLEMENTING SPC

This Chapter looks at how management can intervene in achieving the desired results in implementing Statistical Process Control. In introducing or implementing a new programme in organisations, management must play a significant role. The success of programmes can be guaranteed through the intervention and involvement of management. The systems and cybernetic models discussed in chapters four and five were used as a framework for the management intervention. The discussion includes the managerial alphabets, continuous improvement structure, and barriers to continuous improvement processes.

8.1 A PERSPECTIVE OF MANAGEMENT.

Research and study of successful leaders in a wide range of fields indicate that there are four distinct competencies for successful leadership:

- **Management of Attention**

This is a management style where attention is only paid to situations as they occur. This is a single-loop learning type according to Schon and Argyris definition for learning. In implementing programmes such as SPC, management of attention is not recommended in that problems should not arise before particular attention is paid to the problematic situation. If management believe and explore the benefit of organisational learning a learning cycle may be established at all levels in the organisation in order to address most problematic issues before they escalate.

- **Management of Trust**

This is a style of management where there is trust between each and everyone involved in system under consideration. Individuals trust each other such that information and data made available to them are not doubted and often are used as the basis for making decisions.

- **Management of Meaning**

This is the most appropriate competency for successful leadership. Due to the fact that management need to understand the situation under their management. Tools and methodologies such as Soft Systems Model (SSM), Multiple Perspective (MP), Viable Systems Model (VSM) which have been discussed earlier in this work can used in exploring a problematic situation.

- **Management of Self.**

This is basically managing situations based on the way the group or individual beliefs are fixed as described by Peirce method of apriority.

Most leaders unanimously agree that vision, alignment, empowerment, commitment, and inspiration are the marks of effective leadership in organisations. Management is about change, about realising transformations, about moving a system from a less to a more desirable state. Effective and efficient managers ought to hold appropriate mental model for achieving these. Managers ought to hold mental model of:

i. The current state of the system they are part of, why the system is in undesirable state, and why something should be done about it. An example of this is the question of why SPC is not yielding fruitful results in ADE and some companies while others are enjoying the benefits of SPC.
ii. The future more desirable state and why it is more desirable.
iii. How the world works in the context of a proposed transformation.

A further requirement is that management at ADE need to believe that the current situation of the system under their control can be improved through positive intervention by management. It is only through such a an intervention that management may be able to develop a framework for guiding inquiry into real managerial problems. The quality of a framework is based on the mental model of management and the approach and tools available to deal with a given situation.

At ADE when problems arise in the manufacturing business unit, people are assigned to handle those problems. People are assigned to various problems on the basis of their experience. Most organisations including ADE do not realise that the qualification of a person or group of people to solve problems depends on many factors, of which the majority are determined, not by the problem solver, but the system of which he or she is a part.

8.1.1 MANAGERIAL ALPHABETS (SYSTEMS ALPHA, BETA, GAMMA)

The task of management is firstly, constant reviewing the goals of the organisation, secondly, to direct the organisation towards these goals. These two processes can be considered as a process of design and a process of negotiation respectively.

According to Revans it is rare to find first-class managers, since design is largely associated with intellectual-or mental-process while, negotiation is largely a temperamental-or personality-process, and intellectual and emotional qualities are independent (Revans, 1982, pp.330).

8.1.1.1 MANAGERIAL TASKS: ASPECT OF DESIGN(System Alpha)

A feasible course of action demands that managers must evaluate the outcome of their action and be aware of the difficulties they will need to surmount in order to achieve this outcome. They need to find resources sufficient to deal with these difficulties at a cost consonant with the outcome and must have knowledge of, or information about, a feasible cause of action that they intend to take.

If the managerial task is taken positively, that is, not as overcoming troubles but as grasping opportunities, then the following three questions become important:

i. What needs to be done?

ii. What stands in the way if doing it?

iii. How can these obstacles be overcome?

These are three important questions that organisation such as ADE should address in order to achieve the full potential and benefit of SPC as a quality management tool.

In the managerial task in the aspect of design (System Alpha) these three sets of ideas or elements need to be explored; the nature of managerial values, the external system and the internal system. Decisions affecting organisations are to be- designed in terms of System Alpha.

8.1.1.2 MANAGERIAL TASK: ASPECT OF NEGOTIATION(System Beta)

System Beta provides the underlying logic of the fundamental process of intelligent trial and error, and thus appears in three common processes; the scientific method, the rational decision, and the learning process.

The cycle of negotiation, called System Beta is as follows:

i. A survey stage, in which data upon all three design elements of system Alpha are identified;
ii. a trial decision stage, in which a first design, using System Alpha, is selected from among a number of alternative designs;
iii. an action stage, in which the trial design is implemented either in whole or in part, either in reality or in some simulated form;
iv. an inspection or audit stage, in which the observed outcome is compared with that expected when the first design was selected;
v. a control stage, when the appropriate action is taken on the conclusions drawn from the inspection (such conclusions will be to confirm, modify or reject the first design; or to repeat the cycle of negotiation in the light of experience gained from its first application).

8.1.1.3 THE MANAGER AS A PERSON: SYSTEM GAMMA

The learning process of the manager, and the corresponding change in the system he or she is trying to influence, is thus a symbiosis called System Gamma. The key element in this symbiosis is the ability of the manager to listen, and to change his behaviour upon understanding the systems behaviour. This demands maturity and abandonment of defensive attitudes thrown up around the fortress of the self-image.
System Gamma is the interaction between the manager himself and the situation he or she is trying to influence.

The operation of the Alpha, Beta, and Gamma Systems in the management process is illustrated in figure 8-1.

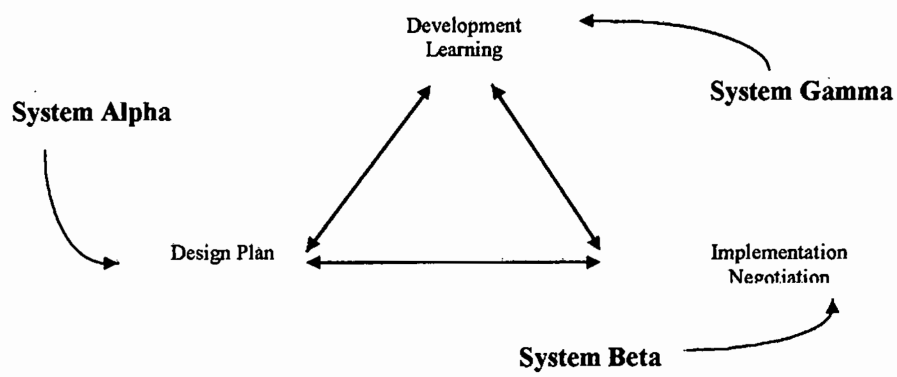


Figure 8-1: THE MANAGEMENT PROCESS (Revans 1982)

8.2 IMPLEMENTATION OF SPC FROM THE CYBERNETIC POINT OF VIEW

As discussed in chapters five and six, the cybernetic and the systems models were considered appropriate in dealing with the situation at ADE.

The organisations need to see itself as a system made up of business units – trading and marketing, manufacturing, and assembly which are also made up of subsystems. In effect the system (ADE) as a whole should be designed in systems view where each and every part or unit, cell contribute the overall performance of the organisation.

The systems model (section 3.2.4.4) over emphasis the interdependency of parts but silent on measure of performance of organisation in achieving its goals.

The cybernetic model looks critically at five systems function S1 – S5 as already elaborated on in chapters four and five. In management intervention of the failure of SPC as a quality management tool using the cybernetic and systems models, management needs to compare the different functions and activities of the parts of

ADE to the ideal cybernetic model. There are indications that some system functions are apparently silent on certain responsibility.

The systems functions S1 – S5 functions discussed in section 5.3 have weaknesses, which was diagnosed using the Viable Systems Diagnosis (VSD). The

8.2.1 OPERATION AND IMPLEMENTATION FUNCTION

The implementation and operations function (S1) is responsible for the activities on the crank line. This function is critical point since measurements and data are taken for analysis using the SPC tools. Operators need to be responsible and accountable for all data taken at this crucial point.

8.2.2 CO-ORDINATION AND COMMUNICATION FUNCTION

The co-ordination function S2 is one of the important functions necessary for the proper implementation of an improvement programme. Co-ordination was one of the factors that surfaced in dealing with the failure of SPC is organisations such as ADE. The co-ordination function ought to address issued concerning the structure for channelling information.

8.2.2.1 TQM STRUCTURE FOR CHANNELLING INFORMATION

For effective management intervention resulting in continuous improvement, the traditional organisational structure and its method of channelling information and ideas need to give way to a Total Quality Management (TQM) structure where bottom-up communication is encouraged. The bottom-up communication promotes commitment of all employees and trust between people at different levels in the organisation. TQM approach to improving the competitiveness, effectiveness and flexibility of a whole organisation. It is externally, a way of planning, organising and understanding each activity, and depends on each individual at each level. The two structures are compared in Figures 8-2 and 8-3.

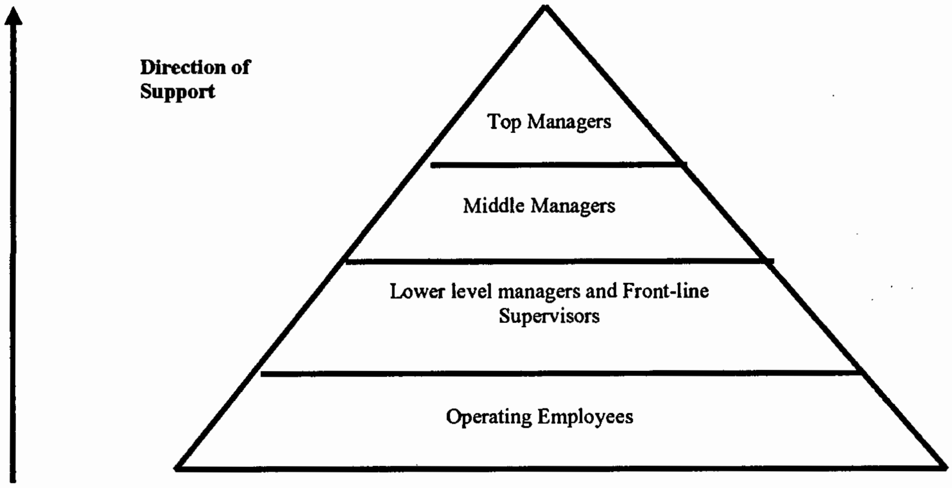


Figure 8-2: TRADITIONAL ORGANISATIONAL STRUCTURE

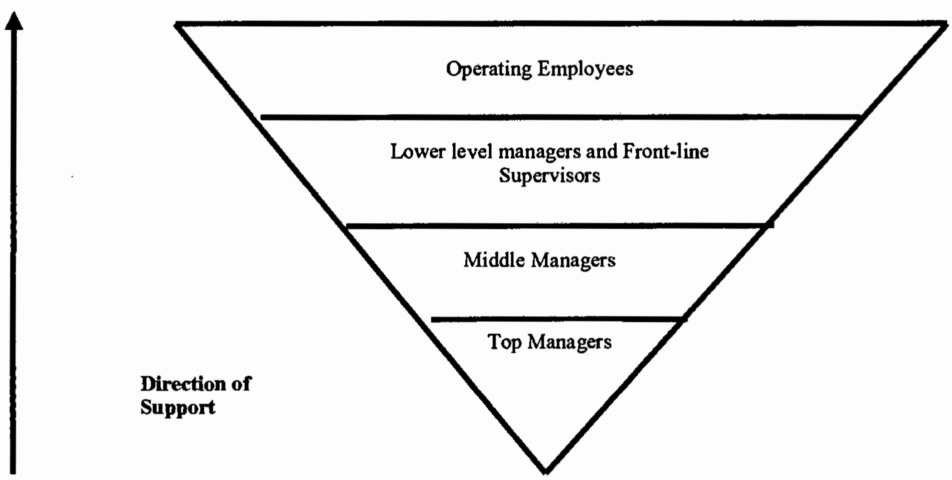


Figure 8-3: TQM VIEW OF THE ORGANISATIONAL STRUCTURE

8.2.2.2 THE STRUCTURE FOR IMPROVEMENT PROGRAMME

Improvement programme has a coherent structure, with three main components: behavioural, management and technical, as shown in Figure 8-4. The structure when adopted and appreciated by organisational members addresses issues that form part of the failure of programmes such as SPC in ADE.

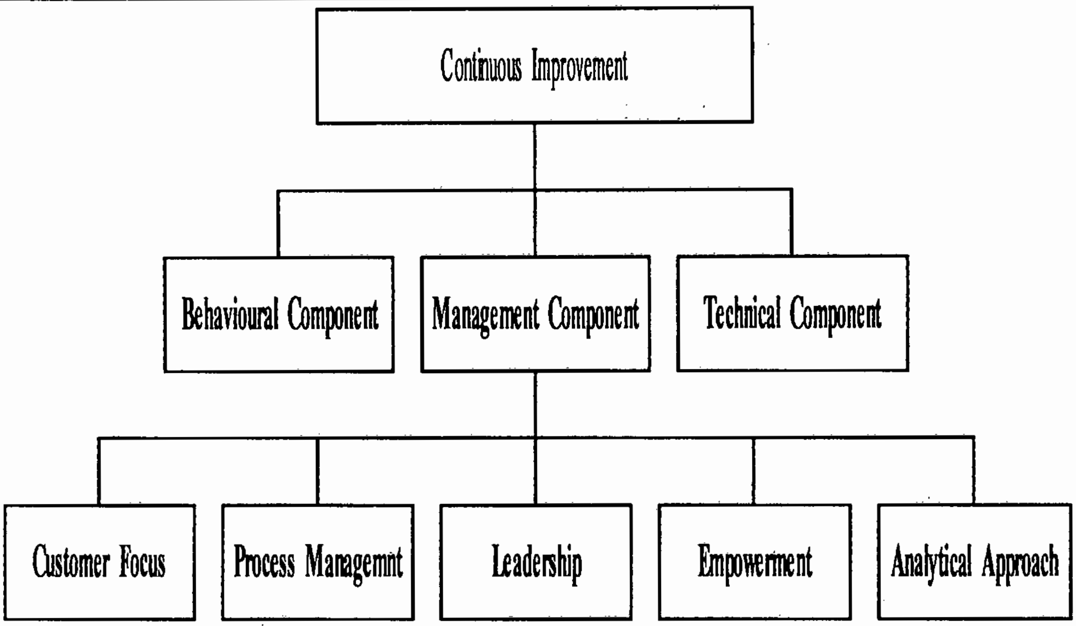


Figure 8-4: FOUNDATION OF AN IMPROVEMENT PROGRAMME

▫ BEHAVIOURAL COMPONENT

The behavioural component is concerned with building an environment in which people can realise their full potential through mutual trust, respect and support between management and stuff. Top management must take the lead by demonstrating their personal commitment to SPC. If management behaves in a manner consistent with the values and beliefs implicit in continuous improvement, then and only then can they expect employees to change their behaviour. Statistical Process Control instigate organisational members to be involved in a process of continuous change that will benefit both the employees and the employers. People need to undergo a complete change of 'mindset' to unscramble their intuition; which rushes into the detection and inspection mode to solve quality problems.

▫ MANAGEMENT COMPONENT

The management component is the infrastructure of SPC. This includes the establishment of agreed goals and shared vision, and measures at every level of the organisation and the consistency of functional and individual goals with the overall goals of the organisation.

- **TECHNICAL COMPONENT**

The technical component is a structured approach to problem solving based on data collection, a disciplined approach to problem prevention, and use of general simple statistical and graphical tools. The *'tools and techniques'* of continuous improvement are aimed at supporting an analytical approach to problem-solving and process improvement.

In attempting to implement SPC most organisations including ADE make the mistake of over-emphasising the technical component. The key is behavioural change. Even in the management and technical components, the behavioural component is critical as elaborated in the organisational culture and behaviour.
Underpinning this structure are the five foundations of improvement programmes: customer focus, process management, leadership, empowerment, and analytical approach.

8.2.2.3 BARRIERS TO IMPROVEMENT PROGRAMMES

A common objection to improvement programmes is that it only works well in Japanese culture. Research on the Japanese working environment reveals that improvement programmes work well in the Japanese context. This is because people are culturally submissive, and more willing to sacrifice their individual interests for the betterment of the whole organisation. In the west, and other parts of the world including South Africa, individuality is regarded in many quarters as a cultural asset, which is threatened by conformity.

The barriers to improvement programmes are found in the nature of change in organisation structures, and in mechanisms for motivation and information dissemination. If management lack detailed knowledge of what is happening in the business processes, who the customers and stakeholders are, what influence the organisation has on the environment and vice versa, then any change introduced may therefore be based on ignorance of detail.

In the case study, ADE faces the problem of lack of knowledge on SPC by management. This is the more reason why improvement programmes discredit top-down change but recommends bottom-up change. In the bottom-up change employees are encourage to suggest changes that may lead to small improvements to the routine way of doing things, which in effect brings about continuous improvement as new suggestions come in regularly and changes take place.

Appendix D lists question that can guide organisations to assess their state so far as the journey towards continuous improvement is concerned.

8.2.3 CONTROL AND AUDITING FUNCTIONS

The control function (S3) and the auditing function S3** may be used as guidelines in the planning and implementation of SPC in ADE and other organisation embarking on SPC. The control and the auditing functions ought to be responsible for the implementation policies set by management. This can be achieved by setting up a target and controlling activities in such a way that the gap between actual and expected may be sealed.

8.2.3.1 PLANNING AND IMPLEMENTATION OF SPC IN ORGANISATIONS

Most organisations in manufacturing business have installed SPC, but the point is that since SPC tools are not properly utilised and analysed the expected value to the operation as a whole is not achieved. Unless efficient quality system is practised, results and subsequent analysis may be flawed. Management is constantly under pressure regarding how their organisations can optimise both efficiency and innovation in this ever-changing business environment. SPC in a real sense is a system-transforming innovation process.

Bushe and Shami (1991) proposed a structure named “Parallel Learning Structure” which describes a technostructural intervention that promotes innovation and change in large, bureaucratic organisations. Parallel learning structure as defined by Bushe and Shami is an intervention where a “structure” is created that operates “parallel” with the formal hierarchy and structure and has the purpose of increasing an organisation's learning. Members of the parallel learning structures are also members of the formal organisation, but within the parallel structure their relationships are not limited by the formal chain of command. This kind of relationship promotes communication and interdependency of the parts of the organisation.

Parallel structures create a bounded space and time for thinking, analysing, and acting which is different from the formal way of doing it. It also provides time and place where organisational inquiry is legitimate. This structure in one way or the other may be described as a steering group for the implementation of SPC.

Organisations introduce programmes such as Statistical Process Control under the false assumptions that if they carry out enough of the *"right"* improvement activities, actual performance improvement will inevitably materialise. Organisations often seem to forget that at the heart of these programmes are often fundamentally flawed logic that confuses ends with means, processes with outcomes. This logic is based on the belief and assumptions that once managers benchmark their company's performance against competitors, and train their employees, the overall performance of the company improves.

SPC tools are used to identify problems, determine the cause(s) of the problem, and monitor the effect of the corrective action implemented. There is a need for employee scrutiny of all the SPC tools for groups to be aware of the state of processes they control or perform and what the root causes are. Control charts and other SPC tools need to be used extensively, otherwise there is no point in its implementation. Ownership is required for the implementation of SPC, this happens to be one of the key factors for the failure of the program and other projects in most organisations. Any new programme introduced and implemented needs some one or group of people to take ownership and be accountable of it. This responsibility must be assigned to a group of people who are committed and are prepare to claim ownership of the programme.

In the case of ADE there is only one person responsible for SPC in the crank cell. This same person has other responsibilities as well, which makes it quite impossible to do all the analysis necessary at the right time.

8.2.3.2 STEPS TO ENHANCE THE IMPLEMENTATION OF SPC

There are various steps that may be taken by organisations embarking on the use of SPC as a quality management tool. The important steps among the many are outline below.

- **OBTAINMENT OF MANAGEMENT SUPPORT**

Top management understanding and involvement of Statistical Process is the top priority for the success of its implementation. Employees on different levels on the organisational hierarchy have different beliefs and views for the implementation of new programmes such as SPC, if management appear not to be part of the programme. It is the responsibility of top management to explain the purpose and importance of SPC or any new programmes to employees in achieving a continuous improvement. Without top management involvement and commitment, shopfloor workers may regard SPC as an implied criticism of their operational management.

- **DEFINITION OF THE PRODUCTION OR SERVICE SYSTEM**

The logical steps of operation of the system under focus must be well defined and understood using the system approach questions such as:

i. What is the operation? - Transformation process
ii. Who does what for whom? - Customer
iii. When is it done? - Time
iv. Where does the product go next? - Customer/Supplier
v. Why is the process operating the way it is? - Behaviour

□ IDENTIFICATION OF SPECIFICATIONS AND STANDARDS

There should be a clear distinction between product specification and control limit. The product specification or tolerance is obtained from the engineering drawing, while the control limit is a function of the sample measurements. A specification can detail surface finish, dimensions, reliability, and/or maintainability.

□ IDENTIFICATION OF PRODUCT CHARACTERISTICS

There should be a clear definition of the characteristic(s) of the product that is of interest and that needs to be measured. In the manufacturing industries physical dimensions such as, length, weight, and strength are monitored or measured.

□ IDENTIFICATION OF LOCATIONS CAUSING VARIATION

Variation in manufacturing and service industries is often due to one or more of the following variables: machines, operators, methods, materials, and environment. The use of the cause-and-effect diagrams basically diagnosed variation based on these variables.

□ DEFINITION OF MEASUREMENT SYSTEM

Measuring equipment should be chosen with the required precision and accuracy, as personnel should well trained to take the measurements and data recordings. There should be a clear and stated period for measurement and the number of measurement per shift should also be stated and followed.

□ FOCUS ON CONTINUOUS IMPROVEMENT

The ultimate goal of the process control chart is to first control a process, and then to improve it repeatedly. Continuous improvement should be more of a learning cycle since all manufacturers strive to attain zero defects in their manufacturing operations.

8.2.3.3 REQUIREMENTS FOR EFFECTIVE TRAINING

For smooth implementation of SPC, training and workshops are necessary. Training such as:

- ***CONCEPTUAL TRAINING***

- Use relevant examples
- Tailor training to suit the organisation
- Implement training at the top
- Follow up with concrete actions

- ***QUALITY TOOL TRAINING***

- Provide time and opportunity to master skills. This is the most significant action an organisation must take to improve effectiveness of training.
- Provide a framework to use skills in the environment. Successful quality tools requires that participants acquire an understanding of how to apply the tools in their own work environment.

- ***SPECIAL TOPIC TRAINING***

- Train employees in the right area
- Organise courses in the right curriculum
- Develop suggested training path for each major group of employees

- ***LEADERSHIP TRAINING***

Provide ongoing feedback. Managers who have completed leadership training need feedback to determine how successfully they are implementing the new management techniques learnt.

8.2.3.4 QUALITY AWARENESS TRAINING

Education and training is an important element of Statistical Process Control. Workshops need to be organised at all levels in the organisation to create awareness of quality and its cost effect among employees.

❑ *TOP MANAGEMENT WORKSHOPS*

The aim of this workshop is the secure the commitment of the top team to a plan to introduce Statistical Process Control. Top management alone can not make SPC work in organisations; they need organisation-wide commitment from a group. This group needs to ensure that sufficient resources are provided and are properly directed.

Top management need to:

- understand their role as behavioural role models;
- establish an appropriate organisation for quality;
- understand the tools and techniques of quality improvement, and how they are applied;
- recognise the importance of 'process' and process capability;
- understand the need to create a climate in which continuous improvement will thrive.

❑ *MIDDLE MANAGEMENT WORKSHOP*

Middle management need to be accustomed and focus on:

- an overview of the structure and foundations to Statistical Process Control;
- leadership, teamwork and team building;
- applying the most commonly used SPC tools and techniques;
- processes, process capability, measurement and process improvement;
- management behaviour;
- introducing Total Quality

The responsibility of middle management also include plans detailing:

- specific opportunities for reducing rework and waste;
- how improvement will be measured;
- what resources will be needed;
- how the improvement projects will be organised.

- ***TRAINING FOR THE FIRST-LEVEL SUPERVISION***

Supervisors must be aware of the position of their organisation in the competitive environment, and as a result the need for Statistical Process Control as a quality management tool that can enhance quality and productivity. Supervisors need training in leadership skills, the common sense principles, and methods of effective communication and above all team building, since they are in contact with the people who perform the main operations of the organisation on a daily basis.

The efficiency and effectiveness of supervisors can be harnessed if they:

- understand the need for change;
- understand the group customers and their requirements;
- understand their suppliers, and working through their requirements with them;
- can identify the business processes they are involved in;
- understand the effect their own quality has on others in the process chain;
- can identify areas of waste, rework and errors;
- understand the use of simple tools and techniques for data collection, analysis, and problem solving.

8.2.4 POLICY FUNCTION

The policy function (S5) is responsible for setting up policies and guidelines for the system (crank cell) under consideration to overcome the problems associated with the implementation of SPC. Management on the other hand need to understand the shopfloor before these policies and guidelines are implemented.

Taiichi Ohno stated that if we do not understand a problem, we should spend time at the shop floor (genba), observing the problem so as to figure out what is wrong. (Suzaki, 1993). Effective management of organisations be it a manufacturing or servicing industry must consider shopfloor management as a powerful tool for improving their production system. Shopfloor management is important in that most of the fundamental value-adding activities take place at the shop floor. On the shop floor, problems are everywhere, from cleanliness to machine maintenance, from improving the quality to increasing productivity, from developing effective communication to fostering team work to accomplish the mission. In effect, there are problems with quality, cost, delivery, safety, and morale (QCDSM) that need to be addressed in order to be competitive.

To implement and utilise a programmes such as SPC, organisations need to meet today's challenges in business that includes:

- Shared vision- philosophy of shopfloor management and continuous improvement.
- Customer orientation - philosophy of Quality Function Deployment and shopfloor management.
- Ownership by people- philosophy of shopfloor management and continuous improvement.
- Problem solving at the source- philosophy of shopfloor management and continuous improvement.
- Self-management- philosophy of continuous improvement and shopfloor management.
- Quality in all business processes- philosophy of Quality Function Deployment, Business Reengineering Process, continuous improvement, and shopfloor management

All these issues can be addressed from the shopfloor upward, and this is the reason why today's manager needs to have a sound knowledge of shopfloor management.

Management generally agree to the fact that if skills are upgraded in an organisation there will be less '*fire fighting*' as is the case in most organisations today. Suzaki (1993) argues that by clarifying our vision, streamlining the process, and encouraging self-management (empowerment), organisations can realise tremendous improvements in quality, cost, delivery, safety and morale, which enhance their competitiveness (Kiyoshi Suzaki, 1993, pp.2).

The shopfloor management philosophy rests on development of people both at the shop floor and up the organisational hierarchy. Organisations without proper shopfloor management experiences problems and have to spend considerable amounts of time 'fire-fighting' problems associated with Quality, Cost, Delivery, Safety, and Morale (QCDSM).

Commitment is the cornerstone of improvement programmes, like SPC and many more. Commitment is an intellectual characteristic, a personal attribute that, like honesty, can not be mandated or imposed from outside. Management has to believe in a programme and be committed to it and must demonstrate their belief. Management commitment must be obsessional; not lip service as it used to be in most organisations. Management may be committed but not to the right thing. Organisations believing that *'quality should be everyone's job'* are at a disadvantage at the end of the day, since this creates unfocused attention and responsibility. There needs to be a clear cut between responsibility and accountability.

It has been estimated that commitment counts 25% when the relative importance of the various factors that determine the success of improvement programmes is weighted (Brown et al., 1994). The others are threat (30%), strategy (20%), progress, (15%), and plans (10%).

CONCLUSION

This chapter has elaborated on the intervention of management in successfully implementing SPC. Based on this discussion it is clear that commitment coupled with training is the foundation for the successful implementation of SPC.

PART FIVE

EVALUATION

This is the final stage of the research cycle. The hypothesis selected for the research is tested at this stage for its validity. If the hypothesis is refuted then a new process of inquiry will start based on Peirce process of inquiry discussed in chapter four of this thesis.

The case studies used for the testing of the hypothesis are mainly Textiles and Packaging industries in the Western Cape. Based on the outcome of the testing, recommendations are made on the research process and the achievement of a learning organisation.

CHAPTER NINE
EVALUATION OF THE FRAMEWORK

The induction stage of this work is the testing of the hypothesis against experience in a given situation and drawing conclusion about the validity of the hypothesis from the test.
The testing of the hypothesis was based on case studies. These cases were mainly organisations or companies who have implemented SPC as part of their quality management system.
Most of the information available for the induction stage is from the packaging, filling and textiles industries in the Western Cape was reviewed.

9.1 TESTING OF HYPOTHESIS

The hypothesis has been stated as;
"The use of Statistical Process Control as a quality management tool in manufacturing industry may enhance quality and productivity by stabilising manufacturing processes. The full potential of SPC may be harnessed by ownership, accountability, training and commitment at all levels in the organisational hierarchy."

Research done by Bhula (1996) on a pilot programme for the implementation of SPC by four textile companies (Dermar Fashions, Florida Clothing, Amalgamated Quiltings, and Romatex Home Textiles) in the Western Cape was reviewed.

9.1.1 DERMAR FASHIONS

The research by Bhula (1996) indicates significant progress in Dermar Fashion at the end of the pilot programme. Operators' awareness was one of the benefits of the programme, and the programme also benefited both operators, in the form of bonuses for increased level of conforming products, and the company as a whole which was a motivation factor for both management and employees. Dermar see the programme as a step towards continuous improvement and competitiveness that is being a world class manufacturing industry in the textile industry. The success of the programme was as a result of commitment on the part of the whole work force with particular emphasis on operators and middle management. The involvement of the employees was through workshops where new statistical techniques were introduced to most of them for the first time. The atmosphere created for the implementation programme also boosted the success of the programme since most of the employees were involved in problem solving processes for the first time and felt being empowered.

9.1.2 FLORIDA CLOTHING

Florida clothing concentrates on mainly lady's fashion operating on short-run processes. The pilot program indicated that the reject rate was high before the company embarked on the SPC implementation program. The proper usage of the SPC tools highlighted some of the problem areas contributing to the high level of reject and rework. With the SPC tools properly understood and the programme being implemented the expected results in the company is a matter of time and commitment on all parties involved in making SPC a reality but not just a *'mouth say.'*

9.1.3 AMALGAMATED QUILTINGS

Bhula (1996) indicated that the implementation of SPC was not successful as anticipated, workers became aware of problem areas and participants were more willing to be involved. Training coupled with management support and commitment was recommended. SPC could be accepted within the industry if further benefits or success are experienced. The company is embarking on continuous improvement programme with long-term expectations.

9.1.4 ROMATEX HOME TEXTILES

The research by Bhula (1996) proved that there was a problem with the use of SPC tools and techniques. With education and training through workshops and problem solving using the SPC tools, Romatex will be able to produce high quality and conforming products. The implementation of SPC benefited the company in terms of the time and money involved in the 100% inspection which was being employed by the company but which was not producing a significant decline in the level of rejects. Employees initially had a belief that 100% inspection was part of the organisation's culture which was challenged after the pilot programme that with the proper understanding and utilsation of SPC tools resources in the form of money, labour time and raw material can be saved instead of using 100% inspection.

9.1.5 MONO PLASTIC PACKAGING

Mono Plastic Packaging in Cape Town, Epping Industrial area embarked on Statistical Process Control about six years ago and there have been a significant improvement in the quality of products conformance to specification. Arend Hofmeyr, an SPC consultant, and developer of QUALISTAT SPC for manufacturing industries introduced statistical Process Control at Mono Plastic. According to Hofmeyr and Rudi Adonis the Quality Control Manager, the introduction of SPC was not as easy journey as anticipated but with the commitment and involvement of top management and all employees significant improvement has been achieved. There were various challenges and obstructions faced by its implementation which according to Hofmeyr were overcome by training and education through workshops for middle management and shop floor workers. The Quality Control Manager stated that "SPC is a powerful quality control tool that has redeemed us from almost all quality problems as a result of assignable causes. SPC is a tool that shop floor workers do not need advance knowledge in statistics to understand. All what is needed to make SPC a success is the atmosphere in which it will be implemented, that is commitment from all to learn and give it a try."

Bhula (1996) argued that the implementation of SPC was not a smooth journey for these organisations. But with commitment, training and practice through workshops and demonstrations, change in organisational and individual behaviour and culture, organisational learning and effective communication of all organisations' members the expected results from the use of SPC can be achieved.

9.1.6 FEEDBACK FROM OTHER SPC USERS

Kohler Core and Tubes: The combination of ISO and SPC has reduced scrap from 14% to less than 0,5%, at least 80% of this was due to the implementation of SPC before ISO. "SPC has continued to pay for itself at least four times a year, I think it should be declared a crime to run any mass production process without SPC"- Yusif Fredericks the Quality Assurance Manager. Management of Kohler Core and Tubes pointed out that gaining competitive advantage in the business world is not just implementing new programmes because competitors have done so. For programmes such as SPC to be successful in companies such as Kohler Cores, there was organisation-wide commitment and support to make it a reality.

Isabella du Ry of **GR Pharmaceuticals** reports: "We have applied SPC in all departments, with positive results-from incoming bottle checks to fill-volume control. We're delighted that our major bottle supplier has also implemented SPC, allowing us to compare apples with apples."

Sandy Buchman, extrusion manager of **Safepak**, has this to say: "SPC pay for itself within the first two months and has since been progressively helped to further improve quality standards."

The laboratory manager at **Peninsula Beverage** (Coca-Cola bottlers) in Cape Town sums up as follows: "SPC has helped to determine the process capability of our own equipment as required by Coca-Cola. The analysis of the SPC data enables us to present a convincing case for the replacement of some old equipment. We have found SPC advantageous when dealing with our bottle suppliers who have now replaced large quantities of bottles on the basis of faxed SPC printouts, whereas previously they were sceptical and argumentative. SPC is a powerful tool and has paid for itself many times over."

Peninsula Beverage, bottlers of Coca Cola, installed the Qualistat SPC system, developed locally by Pinelands (South Africa) consulting engineer Arend Hofmeyer. It is claimed that the Qualistat SPC system has made it possible to process 20 times the amount of data previously possible. The Qualistat SPC system if properly implemented and utilised, moves the process from chaotic state to a more stable state.

The information gathered from these organisations indicate that SPC is a quality management tool which if properly implemented and utilised extensively in manufacturing industries, enhances quality and productivity by cutting down the rate of rejects and reworks and stabilising the manufacturing process.

Proper implementation and utilisation in this context addresses technical issues such as such as:

- obtaining management support;
- defining production or service system;
- identifying specifications and standards;
- identifying product characteristics;
- identifying locations causing variation;
- defining measurement system;
- focusing on continuous improvement.

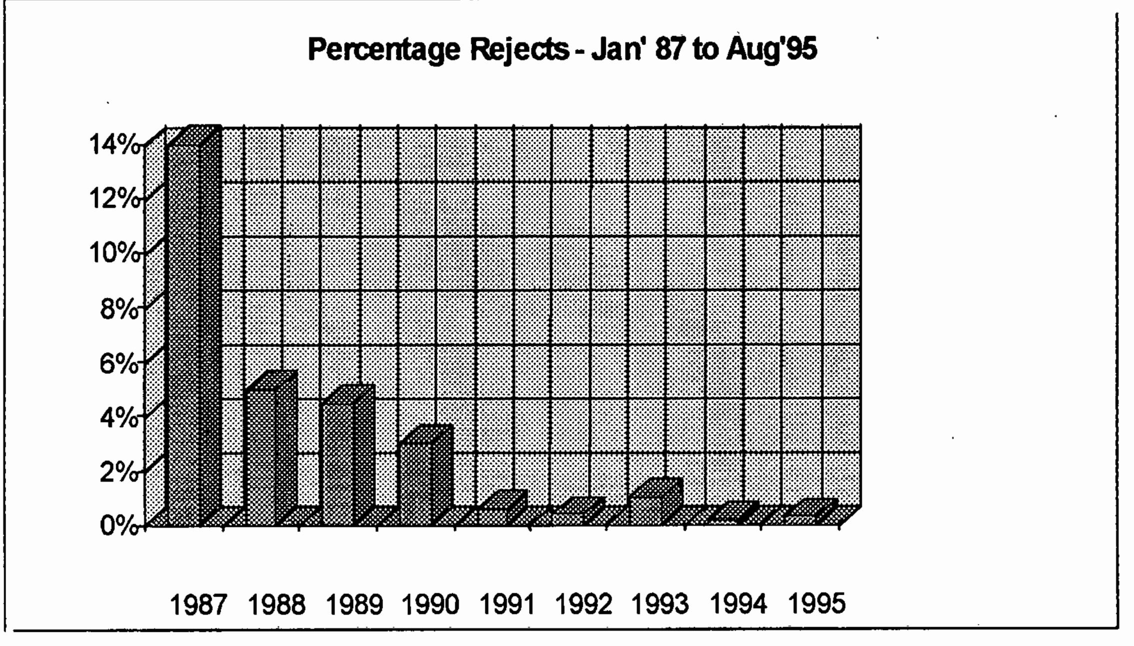
These issues have been discussed in section 7.6.1 of this thesis.

The proper implementation and utilisation of SPC has benefited companies in capturing more accurate and reliable data and automation of the measuring processes. Graphic analysis enables management to compare the quality of different suppliers by detecting long and short term trends in variations, and to access how well suppliers' quality and their own production comply with set standards. SPC charts and trend graphs may be used by organisations as a communication tool when it comes to conformance to standards between the supplier and the producer.

Research and analysis done by SPC consultant Hofmeyr of Qualitstat and Michael Minges of Microcomps CC. in most plastic and packaging industry indicate that implementation of SPC before introduction of ISO yields a positive result.

Graph 9-1 shows the percentage rejects from a plastics manufacturing industry in South Africa. The company implemented SPC in 1987 and after five years in 1992 ISO was introduced.

From the graph it is obvious that there was a gradual drop in the percentage rejects until the year 1992 thereafter the system became stable and consistent after the introduction of ISO.



Graph 9-1: PERCENTAGE REJECTS - JAN' 87 TO AUG'95

Before the introduction of SPC, most production systems were in a chaotic state and out of control. The introduction of the SPC normally brings these systems to a more stable and controlled state. This can be achieve through proper utilisation of SPC tools in understanding and solving problems that arise as a result of variation in system.

CONCLUSION

This chapter has revealed the validity of the hypothesis based on the findings of the outcome of manufacturing organisations world-wide including South Africa. SPC may then be recommended as a quality management tool that may yield fruitful results depending on the planning and the implementation approach used by organisations embarking on its use. Organisations need to realise SPC as an improvement programme with a long-term benefit that has been the case in many organisations striving to achieve a world class manufacturing status.

CHAPTER TEN
CONCLUSIONS AND RECOMMENDATIONS

10.1 CONCLUSIONS

As stated in chapter one, the objective of this thesis was to develop a managerial inquiry framework for effective management.

In developing the problem statement, the soft systems methodology and the multiple perspective served as guidance for the author who employed action research as the research methodology in gaining insight into the problematic situation. Based on the three perspectives (technical, organisational and personal) concrete facts were gathered from all parties (stakeholders) involved in the system under focus (crankcell). There were some difficulties in obtaining the views of all levels of employees using the soft system methodology and multiple perspectives. This is attributed to the varied perception about the author's role in the investigation process. Some perceived the author not be part of the investigation thus portraying a mechanistic model whiles others perceived the author to be part of the system thus adopting a social system. And in other cases there were a lot of contradictions in the data collected because employees did not share common objectives and vision.

The viable system diagnosis of ADE indicates that the implementation or operation function, S1, portrays ADE as an organismic organisation. In such an organisation decisions are taken at a higher level without the majority of the employees being consulted. Employees are thus treated as organs while management act as the brain and sole owners. This promotes the *'we-they'* scenario. With this kind of atmosphere prevailing proper training for the use of SPC is not available to those responsible for the basic operations and processes being monitored by employing SPC.

Viable System Model (VSM) and the Viable System Diagnosis (VSD) were used to identify the causes of failure of SPC at ADE. The five system VSM elements were analysed and compared with the ideal situation of the systems elements as outlined by

Stafford Beers (1981) and Clemson (1984). Outlined below are the causes that were identified:

- The analysis of system 2, the co-ordination function, reveals the poor nature of communication, which often results in oscillations within the crank cell. Lack of communication was observed between production and quality department.

- The control function, S3, is the weakest function and the highly contributing factor to the failure of SPC. The level of responsibility and accountability is not sufficient to maintain the viability of SPC. Employees need to be empowered and be responsible and accountable for their contribution to processes they manage.

- The intelligence function, S4, ADE only concentrates on what other organisations are doing to stay competitive. This often fails since every organisation has its own culture and behaviour. The management of ADE in future need to understand the culture and behaviour of their organisation as well as the external environment before they embark on any improvement programme. Because improvement programmes and packages are specific to a company's culture and behaviour.

- The policy function, S5, lacks commitment in the implementation of SPC in the crank cell. It is only when top management are committed that resources can be available for the full implementation of any programme on a long term basis. Low level commitment means that workers are less willing to learn new skills that adversely affect the success rate and company-wide knowledge. Without commitment, improvement programmes such as SPC however trivial may be unsuccessful and the potential of gaining a competitive edge in the industry may be lost. Commitment on the part of management and employees promotes common vision and objective for members involved in the system under focus. Lack of commitment is evident because SPC has not been fully institutionalised. To institutionalise the use of SPC requires changes in the reporting and control systems; worker authority and empowerment;

commitment and honesty; and organisational behaviour. This may entail intensive training for all employees in the organisation.

- The level of confidence in SPC management team also plays an active role in its failure. Some managers find it difficult to change their mindsets and realise the capabilities of SPC.

The variables recognised and observed as contributors to the failure of Statistical Process Control ADE can be simulated for their validity. Most of the variables that are used in the model have been discussed in this work. Computer software packages such as *Stella* and *Dynamo* can be used to simulate the model for long-term effect but due to the time constraint and the limited scope of this work the model was not simulated.

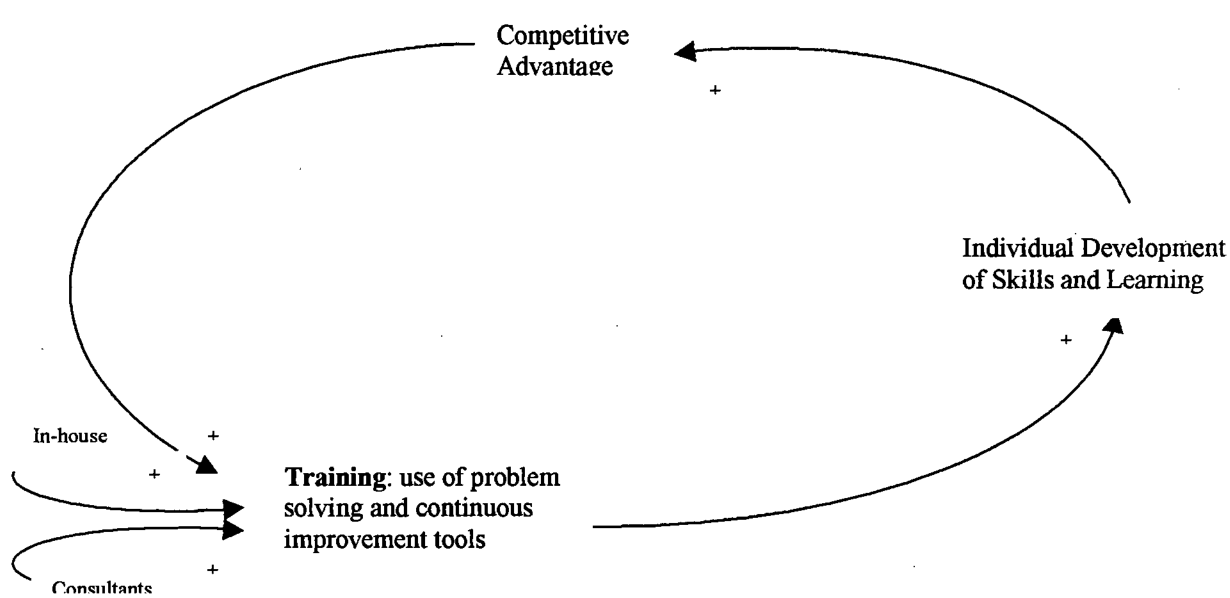


Figure 10-1: INFLUENCE DIAGRAM FOR PROCESS IMPROVEMENT

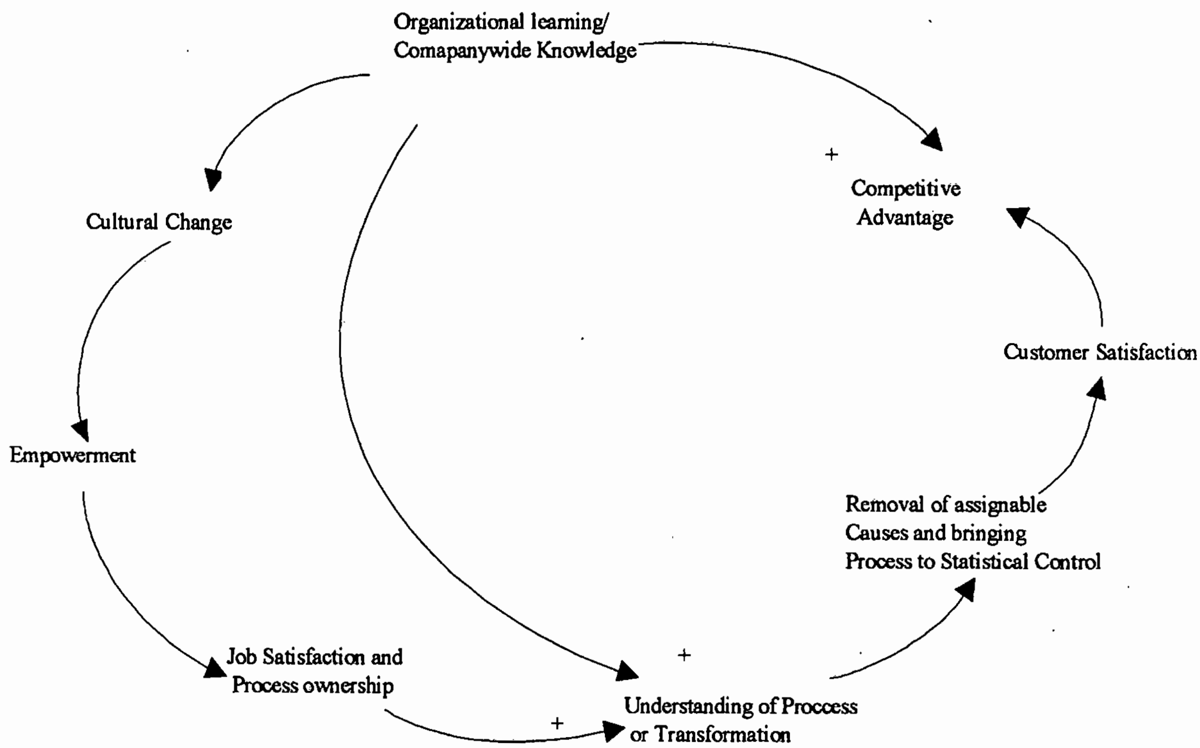


Figure 10-2: INFLUENCE DIAGRAM FOR ACHIEVING COMPETITIVE ADVANTAGE

Organisations wishing to embark on improvement programmes will encounter predictable problems including:

- Lack of management commitment.
- Wasted education and training – implement wrong training or implement training in wrong way. Eventually, executives abandon the effort as a result of lack of tangible returns.
- Lack of short-term, bottom-line result.

These three problems are interdependent. For instance, excessive training expenses can lead to the lack of bottom-line result, which can lead to lack of executive commitment.

One limitation on the usage of SPC in many organisations in the world, including South Africa, typically at ADE is that operators are taught to perform their operations and follow instructions without regard for the results.

10.2 RECOMMENDATIONS

Based on the findings and conclusions of this research the following recommendations were made:

- An efficient and effective communication channel plays a significant role in achieving a World Class Manufacturing status which according to management is the ultimate aim of ADE. The communication and information channelling systems should be improved

- Teamwork should be encouraged with the aim of improving communication channels between functional departments. That is the responsibility of the co-ordination function (S2), control function (S3), and the auditing function ($S3^*$) described in the viable system model.

- Global commitment and teamwork are highly recommended for the success of SPC.

- SPC has been successful in many organisations world wide including South Africa. The proposed model aims at ensuring the successful implementation of SPC. However due to organisational and managerial issues beyond the control of the author it could not be tested in a real life business environment. Further research should be carried out into the feasibility of the model.

Finally, this dissertation should not be perceived as denigrating other factors leading to the failure of SPC in manufacturing industries. On the contrary, it is hoped that the work will help provide more insight into the changes required in manufacturing industries such as ADE that are striving to implement SPC successfully.

PERSONAL DEVELOPMENT AND COMMENT ON THE RESEARCH PROCESS

The research process has given me a tremendous experience in what problems external consultants face in helping organisations in solving the problems they encounter in their working environment.

The main issues encountered were organisational and managerial issues.

Organisational issues includes:

- Policy and organisational identity- the ability to make relevant policies that guide decision making, and establish and maintain organisational identity in a rapidly changing business environment.
- Co-ordination- the ability to gather, translate, and communicate information that facilitate co-ordination and meaningful decision making. This leads to shared vision among the people who manage processes.
- Control- the ability to set appropriate goals, detecting errors and correct them. This process involves monitoring and action.
- Intelligence- the ability to make sense of and model organisation and its environment.

Managerial issues includes:

- Understanding the environment- this is the ability to be effective by doing the right things that make the organisations relevant in its environment.
- Enabling the organisation- this is the ability to be efficient by doing things right and as a result developing the capacity to do things right.
- Settling and resolving socio-technical and political disputes and conflicts by dealing with organisational and technical issues often involving resources, positions, belief systems and consequences

The research gave me the opportunity to interact with industrial personnel (management and shopfloor employment) on professional basis. The use of methodologies such as the systems and the cybernetic models has improve my confidence in critical analysis, decision making, and problem solving.

This masters programme has also improved my group working skills, analytical and critical thinking skills that has prepared me and boosted my basic engineering qualification with the practical working environment.

Figure 10-3 shows the Statistical Process Model.

STATISTICAL PROCESS CONTROL MODEL

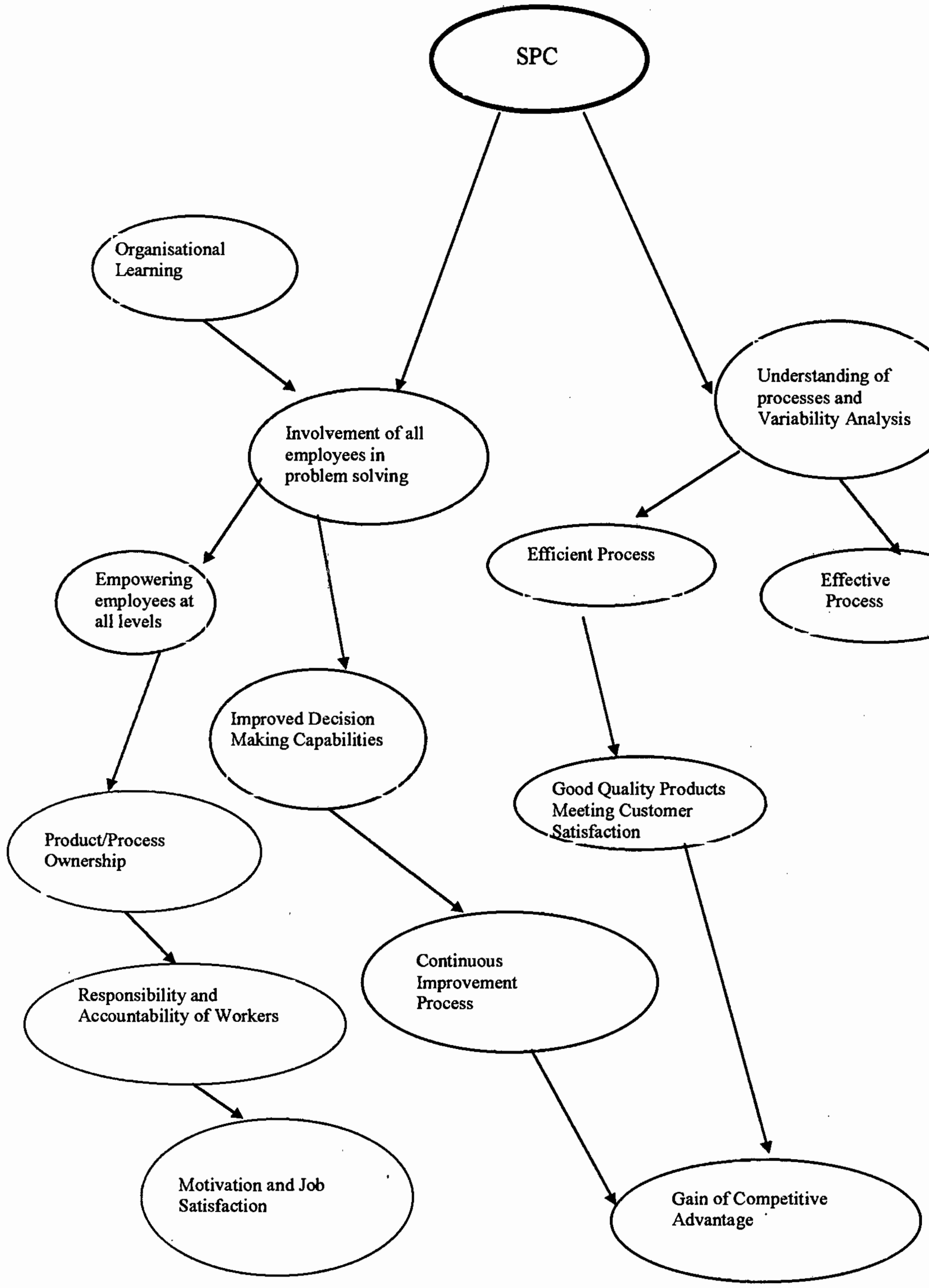


Figure 10-3: STATISTICAL PROCESS CONTROL MODEL

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